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CHINA REPORT
ECONOMIC AFFAIRS
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STATE S&T COMMISSION STUDIES LONG RANGE ENERGY MODELS

Beijing RENMIN RIBAO in Chinese 3 Jul 86 p 3

[Article: "China Establishes Medium and Long-Term National Energy Resources Model that provides Scientific Measures To Formulate Future Energy Policies and Plans"]

[Text] A "Medium and Long-Term National Energy Resource Model" for 10 to 20 years into the future that has been successfully studied by the Qinghua University Institute of Nuclear Power Technology and the Tianjin University Institute of Systems Engineering provides scientific methods and tools for analyzing energy resource plans and policies in China.

The State Science and Technology Commission recently organized specialists in energy and systems engineering and administrative personnel concerned with planning to examine this achievement. The experts feel that this project has scientific, systems and applications qualities in model design, modelling methods and software design. This is China's first large-scale, multi-level state energy resource modelling system, and the theoretical methods and modelling structures achieved international standards.

This research topic was proposed by specialists studying national energy policies and includes a model of predicted energy resource demand and a model of energy supply systems.

Based on China's national economic plans and administrative systems and the characteristics of numerical statistical systems, the forecasted energy resource demand model established by the Qinghua University Institute of Nuclear Energy Technology is a comprehensive modelling system that includes a macroeconomic model and models for calculating national energy demand and regional energy demand. It can reflect the effects of rate of economic growth, changes in industrial structures, scientific and technical progress, changes in the people's standards of living and various other factors on energy demand. The computer software systems developed during their research can be used for numerical inquiries as well as for forecasting various energy demand programs. The related departments have decided to use this software system during the compilation of long-term plans.

The energy supply system model was established by the Tianjin University Institute of Systems Engineering. It involves an examination of energy evaluation,

the distribution of energy development, allocation of investments and their economic effects, arrangements for shipping energy resources, analyzing policies for development of small coal mines and other questions, and it provides quantitative analytical results. It can be used for forecasting the structure of energy supply systems, production, allocation and coordination.

The relevant experts used this model to forecast and analyze energy demands in China for the research report "China's Energy Resources in the Year 2000."

12539/12232
CSO: 4013/151

FOREIGN CAPITAL MAJOR FACTOR IN POWER PROJECTS

HK170107 Beijing CHINA DAILY in English 17 Sep 86 p 1

[Report by staff reporter Xu Yuanchao]

[Text] China will make extensive use of foreign capital to bolster investment in its power industry during the current 5-year plan (1986-90), a power company official has said.

The country plans to add 30,000 to 35,000 megawatts to its total electric power capacity during the Seventh Five-Year plan. One-fifth of it will be built with foreign capital, said Wang Defang, president of the Huaneng International Power Development Corporation.

The task of absorbing foreign funds to build power plants has been undertaken by the Huaneng Corporation, a joint venture between Chinese mainland and Hong Kong companies designated by the State Council for that particular purpose.

The corporation recently unveiled a new batch of power projects which include four thermal power plants with an installed capacity totalling 3,300 megawatts, said Wang.

Wang told CHINA DAILY that a 1,200 megawatt thermal power plant is planned for Shanghai. Three others, with a capacity of 700 megawatts each, are planned to be built in the cities of Dezhou, Yueyang and Chongqing.

Huaneng has sent out bid requests in an effort to select foreign partners for the projects. Negotiations on contracts are expected to be completed by the first quarter next year.

The funds that Huaneng has attracted involve export credits and low-interest and commercial loans. Export credits granted by Western countries account for about 85 percent of the total, Wang said.

New Plants

Since it was established last June, Huaneng has signed contracts to build five thermal power plants with a total capacity of 2,900 megawatts. The

plants, expected to be completed by 1990, will produce 17 billion kilowatt hours (kwh) of electricity a year.

Huaneng, in essence, acts as a negotiating agent for provinces, which put up some of the money for the five plants. The plants will be owned by Huaneng, while local authorities and transprovincial grids purchase the power they generate.

The plants include four 700-megawatt plants to be built in Fuzhou, Dalian, Nantong, and Shang'an in Hebei Province as well as one 100-megawatt plant in Shantou, Guangdong Province, Wang said.

Construction of the Fuzhou Power Plant started early this month with generating equipment imported from Mitsubishi Heavy Industries of Japan. The Japanese company also has provided equipment for a similar plant in Dalian.

Generating equipment for two other power plants in Nantong and Shang'an will be brought from the United States, Canada, and Italy.

The first generator at the Shantou Power Plant, imported from the French company Alsthom Atlantique, is expected to begin operation next month, Wang said.

Electricity Shortage

China turned out 407 billion kwh of electricity last year, but still could not keep pace with the growth of the national economy. The country is short approximately 40 billion kwh a year, according to industry sources.

There is a shortage of power in many rural areas. At present, about one-fourth of all villages and 39 percent of rural residents have never used electricity. According to estimates from power departments, power consumption in rural areas is increasing at an annual rate of 8 percent.

Household electric consumption is likely to expand rapidly with the popularization of household electrical appliances. It is expected to increase to 11.7 percent of the national total by the end of the century from the current 7 percent.

According to the estimates, China's generating capacity must reach 240,000 to 260,000 megawatts to quadruple the country's agricultural and industrial output value by the end of the century, which is the national target set by the State.

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CSO: 4010/76

POWER NETWORK

STATUS OF, OUTLOOK FOR GUANGDONG'S POWER SUPPLY

Hong Kong JINGJI DAOBAO [ECONOMIC REPORTER] in Chinese No 27, 14 Jul 86 p 24

[Article by Hu Chuangwei [5170 0482 0251]: "The Current Situation and Future Prospects for Guangdong's Power Supply"]

[Text] The power supply question has been a persistent and major factor that restricts development of the national economy in Guangdong Province. Guangdong Provincial Governor Ye Xuanping [0673 6693 1627] pointed out at a conference not long ago that Guangdong must focus on safeguarding electric power construction in both the scale and structure of investments during the Seventh 5-Year Plan.

I. There Has Been a Dramatic Increase in Power Consumption Since Opening Up to the Outside World

Guangdong Province is one of China's fastest developing regions and also one of China's provinces with serious power shortages. Per capita electricity use in Guangdong during 1984 was 270 kWh, below the national average of 360 kWh. Preliminary estimates indicate that average daily demand for electricity in Guangdong's continental power grid was 48 million kWh in 1985, while power supplies in the grid were only 32.5 million kWh (not including 3.5 million kWh sold to Hong Kong), which is a 30 percent power shortage. The figures are even higher during the dry season. Guangdong has a shortage of about 4 billion kWh each year, the equivalent of about 600,000 to 750,000 kW in installed generator capacity.

According to statistics, the Guangdong Provincial grid currently has about 4 million kW in installed generator capacity, which includes 2.4 million kW at hydropower stations. Moreover, most of these hydropower generators are small rural hydropower installations, the figure being about 1.45 million kW for this group. Large hydropower stations under provincial jurisdiction account for only 690,000 kW. A significant proportion of these small rural hydropower stations lack reservoirs. Most depend on available runoff to generate power, so it is quite difficult for them to maintain power supplies. Instability in Guangdong Province's hydropower supplies means that thermal power generators often must be operated under overload conditions despite their problems, with utilization rates as high as 7,000 hours per year, far in excess of the national average utilization rate of 5,000 hours per year.

As I understand it, the power shortage in Guangdong is due on the one hand to the long-term weakness in the foundation of the electric power industry and the fact that electric power construction even today is handled as local projects, and on the other hand to the rapid growth in electricity use for industrial production, construction of special economic zones, tourism, hotels and restaurants and the people's daily lives that has followed opening up to the outside world and reforms. This is especially true of electricity use in industry, which accounts for about two-thirds of total electricity use in Guangdong.

The Seventh 5-Year Plan includes planned arrangements for a 9 percent average annual rate of growth in gross value of industrial and agricultural output in Guangdong, which is somewhat higher than the natural average of 6.7 percent. The main reason for this was a consideration of the fact that Guangdong has been able to form a conventional scale production capacity during the past 7-plus years of opening up and reforms and that electric power supplies undoubtedly are a very important key link in meeting the needs of these production forces. An official in Foshan told this reporter that guaranteed electricity supplies alone would permit Foshan to increase its industrial value of output during 1986 by 30 percent over 1985 without additional investments and equipment.

II. Raising Capital and Utilizing Foreign Investments To Build the Power Industry

This situation has led Guangdong Province to formulate an electric power construction plan for the Seventh 5-Year Plan. This plan includes closer linkages with Guangxi, using multiple channels to raise capital and foreign capital to build the power industry. Additions to installed generator capacity will be 3 million kW, including 2.5 million kW in large and medium scale thermal power plants. It has been predicted that by 1990, yearly electricity output in Guangdong Province will reach 29 billion kWh, 66 percent higher than in 1985. There also are 1.5 million kW in power generators and 1.8 million kW in nuclear power plants under construction, and there are a number of power stations where preparatory work now is underway that are paving the way for economic development over the next decade. Guangdong will experience an obvious improvement in its electricity shortage situation.

However, an official with the Guangdong Provincial Economic Commission's Office of Energy revealed that most of the generating capacity to be added in Guangdong will not begin producing power until after the Seventh 5-Year Plan, and that a significant shortage of electric power will persist in Guangdong Province over the next 1 or 2 years. For this reason, Guangdong Province recently adopted temporary measures to invest U.S.$73 million to import 53 large diesel generator sets with a total installed capacity of almost 340,000 kW from Japan and the Federal Republic of Germany. Most of these generators will be installed in the Zhu Jiang [Pearl River] Delta, although some will be installed at Zhanjiang, Shantou and other areas. Many of these generators have already begun producing electricity and are playing an emergency role.

III. Exploiting Thermal Power, Transforming Hydropower

At the beginning of 1986, the Guangdong Province Energy Conservation Society and Guangdong Province Energy Resources Research Society jointly convened the

"Meeting To Discuss Countermeasures for Rational Power Generation and Supply" attended by related units that analyzed and studied the situation in electric power supply and demand in Guangdong Province and the current situation in electricity utilization. Moreover, to deal with the large proportion accounted for by hydropower in Guangdong and the instability arising from fluctuations in power generating capacity between the dry and rainy seasons, the meeting proposed a series of measures to exploit potential in thermal power, including guarantees of requirements of thermal power plants in fuel supplies and operation.

It has been learned that thermal power as a proportion of Guangdong Province's total installed power generating capacity will rise from 39.6 percent in 1985 to about 60 percent in 1990. The most significant projects are the Shajiao A power plant with a total installed generator capacity of 1.2 million kW and built using capital raised by Guangdong Province, and the Shajiao B power plant with a total installed generator capacity of 700,000 kW and built through joint investments by the Shenzhen Electric Power Development Company and Hong Kong's Hehe Power Company, Ltd.

Recently, this reporter made a special visit to plants A and B of the Shajiao power plant, located in Lukouzhen in Guangdong Province's Dongguan City. According to the chief engineer at the Shajiao A Project Guidance Bureau at the Shajiao Power Plant, the first three generator sets, each with a capacity of 200,000 kW, will go into operation in 1986, 1987, and 1988, respectively. The first generator was installed at the beginning of April 1986, and construction of a coal harbor, coal shipping system, water supply system and other equipment has been speeded up. I learned that the two generators, each of 350,000 kW capacity, to be installed in Plant B will go into operation during mid-1987 and at the end of 1987.

This reporter also learned that Guangdong Province has combined accelerated construction of thermal power with continued work to exploit and transform small hydropower stations by changing the passive situation of 1) losses caused by a lack of match-up among power transmission and transformation, reservoir capacity and generators, 2) power outages and 3) low annual utilization times. Guangdong Province also will strengthen administration of electricity use and strive to popularize energy-saving electrical products.

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MORE HYDROPOWER STATIONS ON HUANG HE PROPOSED

OW181430 Beijing XINHUA in English 1417 GMT 18 Aug 86

[Text] Beijing, 18 Aug (SINHUA)--Chinese experts have proposed to build an additional nine or ten hydroelectric power stations on the upper reaches of the [Huang He], China's second longest river.

The projects are feasible, said Luo Xibei, deputy director of the Hydrowpower Project Construction Bureau and deputy head of a group which surveyed from 10 July to 6 August the sections of the river in northwest China's Qinghai, Gansu, and Ningxia.

These will bring the number of power stations to 14 or 15 in the areas, to increase the installed generating capacity to 13 million kW and the annual electricity output to 50 billion kWh.

Since the 1950s, four hydroelectric power stations have been built in Yanguo, Liujia, Bapan and Qingtong gorges in Gansu and Ningxia, and another station is being built in Longyang gorge in Qinghai.

The five have a combined generating capacity of 3.24 million kW and can produce 15.6 billion kWh of electricity annually.

The upper course of the river has rich hydroelectric power potential which the scientists said is easy to tap.

To tap such resources will also contribute to exploiting the areas' rich mineral resources of copper, lead, zinc, and nickel, and raw materials for the building industry.

The construction of these new power stations is also aimed at providing enough energy for a projected economic take-off of the areas at the turn of this century, the experts said.

/12624
CSO: 4010/72

LONGYANGXIA PROJECT SET TO GENERATE POWER BY 1987

Lanzhou GANSU HUABAO in Chinese No 3, 1986 pp 24-25

/Excerpts/ The Longyangxia hydroelectric station, a major State construction project, is located on the line between Gonghe County and Guinan County. It is 146 km from Xining City and some 1,684 km from the source of the Huang He and 3,776 km from its mouth.

The concrete gravity dam of the Longyangxia hydropower station has a height of 177 meters; the reservoir has a capacity of 24.7 billion cubic meters. Four 320MW generators will be installed for a total installed capacity of 1.28 million kilowatts. Annual power output will be 6 billion kilowatt-hours.

After the Longyangxia hydropower station has been completed, power generation will be its chief role but it will also serve flood prevention, irrigation, and reduce the menace of ice, etc. It will also provide impetus to agriculture and industry in Qinghai, Gansu, Ningxia, and other provinces and regions.

After the reservoir of Longyangxia has been filled, the flood-prevention standards of the existing downstream hydropower stations will be enhanced. In any given flood season, it can completely eliminate the threat of the Huang He to the downstream population. At the same time, the Longyangxia hydropower station can generate electricity during the ice season, thereby resolving the problem of systematic supply of power.

The 4th Engineering Bureau, subordinate to the Ministry of Water Resources and Electric Power, is in charge of building the Longyangxia hydropower station. This idealistic, disciplined, and hard-fighting hydropower contingent is fairly highly mechanized and has accumulated a wealth of experience in the area of hydropower station construction.

After completing the three large and medium hydroelectric power stations of Liujiaxia, Yanguoxia, and Bapanxia in Gansu Province, this bureau shifted the fight to Longyangxia and has already spent 10 years there.

In June 1985, the Ministry of Water Resources and Electric Power gave approval for the Longyangxia hydropower station to begin impounding water in September-October 1986, for two of the turbines to generate electricity in 1987, for all four turbines to generate electricity in 1988, and for work to be completed in 1989.

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CSO: 4013/158

HONGSHUI HE'S HYDROPOWER RESOURCES BEING QUICKLY DEVELOPED

Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 19 Aug 86 p 1

[Text] The hydropower resources of the Guangxi Zhuangzu Autonomous Region are being rapidly developed. Today, two cascade stations with five generators with a total installed capacity of 460,000 kilowatts are generating power. The Yantan hydropower station is the first of three hydropower stations either under construction or upon which preparations are being made to begin construction; projects with close to 2 million kilowatts in power-generating equipment are being constructed.

The section of the Hongshui He that flows through Guangxi is 1,050 kilometers in length and the bulk of this section flows through the Yungui Highlands and the Huanan Wuling Plains, a region with rich hydropower resources. The ten cascade stations to be built--Dahua, Yantan, Tianshengqiao low dam, Tianshengqiao high dam. Longtan, Ertan, Pingban, Bailongtan, Qiaogong, and Datengxia--have a total installed capacity of 12 million kilowatts and will generate some 50 billion kilowatt-hours of electricity a year. By the end of this century and the beginning of the next, these hydroelectric power stations, once built, will not only supply Guangxi with sufficient power but will also transmit electricity to Guangdong, Hong Kong, and Macao.

The projects involving the development of the hydropower resources of the Hongshui He have caught the attention of the whole world. This year the World Bank has made a loan of 55 million U.S. dollars for the construction of the Yantan hydropower station. Companies from the United States and Japan have sent experts to the Hongshui He for inspection tours who also expressed interest in making financial and technology deals with the Chinese side.

Of these ten cascade hydropower stations, construction began on Dahua in 1975 and the major part of the first phase of the project was completed in June of this year. It can supply some 2 billion kilowatt-hours of electricity a year to the grid. Yantan is the largest (installed capacity: 1.1 million kilowatts) and it is hoped that it will block the flow of the river in early 1987.

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CSO: 4013/161

BRIEFS

WORK ON LIJIAXIA BEGUN--Early-stage preparatory work on the Lijiaxia hydroelectric power station--another big power project on the upper reaches of the Huang He--is being accelerated. In September 1985, the State Planning Commission formally approved the building of the Lijiaxia hydropower station, stipulating that the work would officially get under way in 1988; total cost would be 1.663 billion yuan. Plans call for a total installed capacity of 1.6 million kilowatts and an average annual power output of 6 billion kilowatt-hours, surpassing that of the Longyangxia hydropower station now under construction. [Text] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 12 Jul 86 p 3] /9738

CSO: 4013/153

DEVELOPMENTS, PROSPECTS FOR POWER PLANT BOILER TECHNOLOGY

Shanghai DONGLI GONGCHENG [POWER ENGINEERING] in Chinese No 1, 15 Feb 86 pp 7-11

[Article by the Special Boiler Commission of the Power Engineering Society]

[Text] I. Developments in Power Plant Boiler Technology

1. Experimental research achievements

During two sessions of the annual conference of China's boiler technology workers, a great deal of experimental research work to solve problems that occur during boiler operation at large-scale power plants was done in conjunction with the development of new types of power plant boilers and improvement of old generators and some gratifying achievements were made.

1) Combustion

A great deal of experimental research has been done in a comprehensive examination of combustion and rich experience has been accumulated for the gradual formation of technical styles suited to China's fuel characteristics.

To deal with combustion stability and to improve the burning efficiency of poor quality coal that has low volatility and a high ash content, the Central China College of Engineering undertook experimental research on passive body burners and did a large number of cold and hot state modelling experiments to derive an understanding of the relevant mechanisms and the influence of structural factors. The results have been applied in some generators with initial success. Installation of a passive body on the No. 6 boiler at the Huangshi power plant, for example, increased boiler efficiency by 3.77 percent. When burning poor quality coal with an ash content as high as 50 percent, the Jinshan Power Plant was able to achieve stable combustion without using oil for ignition.

Qinghua University joined with factories for successful research in pre-burning boilers that has been applied in boilers at power plants that burn butiminous coal, poor quality bituminous coal and lean coal. They have reduced the use of oil in startup and can maintain stable combustion under low load conditions.

Fluidized-bed technologies in China have reached advanced world levels. Problems of fluidized-bed working conditions and their heat transfer, wear, and other questions have been solved in recent years and 35 T/H stone coal-burning boilers and 130 T/H gangue-burning fluidized-bed boilers have undergone technical examination and approval and put into normal operation. Good results also have been achieved in normal pressure fluidized-bed boilers and at coal-water mixture fludized-bed boiler experiment stations. An example is the Furnace Chamber Modelling Experiment Station set up by the Shanghai Power Generation Equipment Research Institute. It has taken up various testing programs to determine the structural parameters that affect air currents in furnace chambers. This has led to obvious improvements in airflow within boilers and the results have been used in the design of new boilers. To digest imported technologies, 300,000 and 600,000 kW boiler stove chamber and burner cold modelling experiment stations now are being set up and preparations are underway for construction of a hot state experiment station. The above boiler plant has established a water modelling experiment station to study rational flame angles and the special dimensions of flue pipes and the results have been used in new boiler designs. To solve problems in burning anthracite and poor quality bitumenous coal, the Wuhan Boiler Plant joined with Xi'an Jiaotong University to develop experimental research on core draft and the use of eddy interference from larger flame bases to achieve stable ignition.

The question of wear on the heat-receiving surface of the tail-end counterflow was a serious problem for a while when burning poor quality coal with a high ash content in power plant boilers. In recent years, research has been done on the basic laws of wear and on the working conditions of airflow in the pipe-beam smoke corridor of the heat-receiving surface. Positive results have been achieved and the problem of serious wear basically has been solved.

2) Hydrodynamics

Several experimental research projects have been done concerning the hydrod namics of direct current boilers, the main ones being: flow and heat transfer of dual-phase fluids in internally threaded pipes, the distribution of dual-phase fluids in mixers and collecting boxes, the lowest safe bulk flow rate in water cooled walls and the flow distribution in each pipe screen of water-cooled walls. Achievements have been made in all of these topics and they have been used to improve existing generators.

3) Heat transfer

Problems in offset design values for superheated steam temperatures and reheated steam temperatures: Investigation has shown that the main problem is the method used to calculate heat transfer in stove chambers and screen-type superheaters. Experimental research and theoretical analysis as well as a large amount of measurement data have permitted the preliminary establishment of heat transfer calculation methods adapted to Chinese fuels and boiler characteristics.

Problems in screen heat differentials: Rather substantial heat differentials exist in screen-type superheaters, countercurrent superheaters and between each of the pipes in the same screen of a superheater. After this problem was discovered, a great deal of experimental research and theoretical analysis were done to establish methods for calculating heat differentials in the same screen. In addition, wall temperature calculation methods and computer programs adapted to modern large-scale boiler structure characteristics were established by considering heat differentials in single screens, flow differentials and smoke temperature differentials along the axes of collecting boxes, and other factors.

The temperature regulation problem in reheated steam: Various unit in recent years have carried out large amounts of experimental research and analysis concerning different forms of temperature regulation like smoke recycling, smoke dampers, steam heat exchangers and other things. A preliminary understanding of dynamic characteristics has been gained and principles have been established for determining the heat regulating quality of reheaters. This is especially true of the large amount of experimental research and theoretical analysis concerning the use of smoke channel dampers for temperature regulation in the burning of poor quality coal, and a preliminary understanding of the problems that should be focused on in temperature regulation designing that uses dampers and of the principles that should be followed.

4) Strength of boiler components

With the increased demand being placed on power station boilers and generators for variable load operation and peak regulation, problems of fatigue strength and lifetime wear of the related boiler components have become increasingly prominent. Research has been done in China concerning the life of cracked steam vessels and countermeasures have been proposed to guarantee safe operation. The question of fatigue life has become one topic in the design of new types of large generators, and stress analysis methods are beginning to be used in boiler design. Calculations have been made concerning the safety and lifetime of components under stresses from internal pressure, gravity, thermal swelling and so on and their nature is such that they exceed the traditional requirements for calculating the strength of pressure-bearing components.

2. Progress has been made in technical importing

Under the excellent situation of opening up to the outside world and after approval by leading comrades in the State Council, the Ministry of Machine Industry signed a technical transfer contract with the CE Company of the United States in 1981 for subcritical pressure controlled-cycle boilers and a technical transfer contract also was signed with the Vacuum Preheater Company of the CE Company for Junker's vacuum preheaters. Technical importing has progressed rather quickly over the past 3 years and more, and technical imports now are playing roles in design, technology, plant technologies and equipment and other areas, which has led to faster development of boiler technologies and reduced the difference between China and advanced world levels.

To permit even better study, absorption and understanding of the advanced technologies from the CE Company, it has been decided that a 300,000 kW and a 600,000 kW test generator will be installed at the Shiheng and Pingwei power plants, respectively. China has sent design personnel [to the United States] to participate in quoted price design and engineering design, and they have completed construction designs after returning to China. Manufacture of the 300,000 kW and 600,000 kW [generators] is expected to be completed in 1986 or 1987.

These two test generators are new 1980's-era products of the CE Company of the United States and are at an advanced modern levels in terms of their capabilities, reliability, and degree of automation. Design and manufacture of these two generators has reduced the gap between China's power plant boilers and modern world levels and it has permitted China to gain a firm grasp of design and manufacturing techniques, which has prepared the conditions for electric power departments to provide high quality boilers during the Seventh Five-Year Plan.

Technical transfer relationships have provided China with a means of obtaining large amounts of advanced technical information from foreign countries. Quite a bit of technical information has been obtained from the CE Company in recent years that includes various designs and plans, standards, demonstration illustration and so on. We sent engineering and technical personnel to the CE Company for training and to participate in design work, and experts have been sent abroad to participate in the relevant specialized conferences. These activities have given us a rather deep understanding of advanced foreign technologies.

3. Transplant imported technologies, update and replace old products

China imported controlled-cycle boilers from the CE Company, but their design ideas, design experience and applications software also can be used to update old products, which is a form of integrating foreign and Chinese technologies.

Work on perfecting the 300,000 kW UP direct current boilers formerly manufactured near Shanghai has permitted them to reach useable levels, but there still is a substantial difference in comparison with foreign countries. In addition to the use of DC boiler technologies known in the past, a large amount of imported technology has been absorbed at the Shidongkou project. Besides absorbing perfected structures from foreign countries, efforts also have been made in design work with the goal of attaining the depth of design work in the CE Company, and we are striving to make qualitative advances in improved designs for traditional products.

The East Boiler Factory originally produced 200,000 kW natural cycle steam enclosed boilers and accumulated experience in the area of natural cycling. At the Lunan [southern Shandong] project, a large amount of foreign technologies were absorbed and major improvements were made in the area of structures to design and manufacture special 300,000 kW subcritical pressure natural cycle steam enclosed boilers. Other examples include the new 670T/H boiler installed at the Douhe Power Plant, the 680T/H oil-gas boiler exported

to Pakistan, a steam enclosed boiler matched with a 200,000 peak regulation generator set, and so on, all of which have absorbed imported technologies to different degrees.

4. Devote major effort to develop and design software to update design procedures

Calculation software was obtained from the CE Company during this technical importing work, including programs for heating power calculations, wall temperature calculations, pipe system stress analysis calculations, strength calculations for pressure-bearing components and so on. These programs now are being placed into Chinese computers. China also has worked on its own in recent years to develop calculation software. Besides the previously developed heat/power calculations (standard Soviet Union method), there also are hydrodynamic calculations for DC boilers, natural cycle calculations, wall temperature calculations, superheater flow rate differentials and other calculation programs. In the design of the steel frame of the Shidongkou Power Plant, computers were used to aid in design and plotters could draw working diagrams directly according to the results of design calculations. Computers now are being used universally in design work and they can promote standardization of designs and encourage reforms in design management systems.

5. Develop new products

Day-night, weekday-weekend and peak-valley differentials in all of China's power networks have increased in recent years, but all of the domestically-produced generators now operating in our grids at present were designed for carrying base loads and constant pressure operation. They generally can operate only at 60 to 70 percent loads or higher and have rather poor peak regulation capabilities. At the Shouyangshan Power Plant project, 200,000 kW peak regulating generators were designed and manufactured. To deal with the frequent startups of peak regulation generators and substantial load changes, a group of corresponding structural measures have been adopted.

The controlled cycle boilers imported from the CE Company also are being redesigned to expand the range of suitable coal types. Design work on 600,000 kW lignite boilers and 300,000 kW lean coal boilers now is underway.

Other these past few years, there also have been several manufacturing plants that have added large scale power plant boiler manufacturing lines.

6. New advances in manufacturing technology levels

China's large scale boiler manufacturing plants are not substantially different from those in foreign countries in terms of plant conditions, but the difference in technical equipment is rather substantial. Several types of new key equipment have been added in recent years, including things like the manufacture of gantry welders for membrane water-cooled walls, MIG welders used to weld pipes together, medium frequency induction welders, corrugated board production water lines, linear accelerators, Cobalt-60 flaw detectors,

pipe weld crater fluorescent screen radiation flaw detectors and other quality inspection equipment. In addition, Chinese designers have integrated with production of the test generator sets to manufacture thick-walled pipe benders, C-type pipe benders, small R-shapers and other production technique equipment. In addition, we have adopted light pipe reinforced steel multi-head buried-arc welding, medium frequency welding, automatic rotating argon-arc welding, interior hole argon-arc welding, CO gas-protected welding and other new techniques, and low-alloy high-strength steel steam vessels with a wall thickness of 145mm also have been successfully developed.

7. Current Gaps

1) Unit generator capacity

People today generally feel that the most appropriate single generators unit capacity in newly constructed power plants is 300,000 to 700,000 kW. Although China is capable of manufacturing 300,000 kW generators and is beginning to manufacture 600,000 kW sets, there is no way that production capacity can meet the needs of electric power construction.

2) Steam parameters

Supercritical parameters are being used in 300,000 to 450,000 kW and larger generators in foreign countries like Japan and the Soviet Union. The United States has a certain number of supercritical generators and Western Europe now is studying developmental problems in supercritical generators. China rose up to subcritical parameters 10 years ago but still has not developed plans for supercritical parameters to this day. This point is especially deserving of the attention of relevant leadership departments.

3) Generator reliability

Regardless of the type of boiler, generators in foreign countries have attained rather high reliability. There is a rather substantial differential in China in this area. The main reason for this is that there is a great difference in the depth of design work compared with foreign countries, and there may even be complete blanks. There are major differences compared with foreign countries in areas like manufacturing techniques, quality control and the quality of matching parts like water pumps, valves, ash blowers, actuating mechanisms, automatically controlled components and control equipment, coal pulverizers and pulverizing systems and so on. It has been predicted that after the 300,000 and 600,000 kW test generators and the 300,000 kW natural cycle and single furnace chamber DC boilers go into operation, there may be a substantial increase in reliability compared with the past, but we must continue to solve problems with things like valves, automatic controllers and other matching equipment.

4) Generator flexibility

Many economically developed nations stipulate that large generators at 300,000 kW and above must be able to bear intermediate loads, and the supercritical generators produced in recent years can operate at variable pressures. Most of China's generators today were designed to carry base loads and have a small range of load variation. They have poor operational abilities for long-term operation at low loads, take a long time for startup, are complex to operate, consume large amounts of energy, have boiler components that were not designed to meet a high number of cycling times and so on.

Generators in foreign countries generally take into consideration a capacity to adapt to accident situations, like RB and FCB. In recent years, China's new 300,000 kW generators have begun to be designed according to this type of requirement.

5) Levels of automation

The differences in this area are obvious. This sort of disparity has led to backwardness in the capabilities of China's generators as well as to declining safety and poor economic results. Of course, the generators themselves also require additional improvements to adapt them to automated operation. In foreign countries, the boiler manufacturing plants generally assume responsibility for the design of boiler islands and BTG plates, and they also organize the supply of materials. China needs to make continual system reforms to strengthen work in this area and improve automation levels in power plant boilers as soon as possible.

6) Matching capabilities and component matching levels

In foreign countries, boiler equipment usually is supplied in complete sets that include coal pulverizers, air suppliers, air intakes and so on. China usually supplies only the boilers themselves and they are not fully outfitted technically. This has major effects on improvements in generator standards.

7) Environmental protection

Foreign countries have clear requirements concerning the discharge of NO_x and SO_x from boilers. Although China has drafted similar laws, they have not been implemented.

We feel that besides historical factors, the primary reasons for the differentials outlined above are a lack of a unified long-term development plan, a failure to achieve good implementation of existing plans, backward scientific research work and frequent policy changes. China's existing technical forces are unable to organize well, and there also may be departmental separations, insufficient development of scholarly activities and so on.

II. Proposals for Future Power Plant Boilers

To reduce the gap between China and world levels quickly and make it possible for the power plant boiler industry to adapt to the needs of power station construction during the Seventh Five-Year Plan, we adhere to the principle of "importing, digesting, developing, and innovating" in proposing that we:

1. Formulate long-term development plans for power equipment (used in power plants as well as in industry).

The technical equipment policies of users should be unified with manufacturing departments to organize all of the relevant engineering technology forces in China into a division of labor and cooperation and to encourage each to make use of its advantages, and certain encouragements and preferential treatment should be given in policies to assist in providing the necessary equipment and conditions.

2. Strengthen work to digest and absorb technical imports.

The design and manufacture of 300,000 to 600,000 kW test generators was completed during the Sixth Five-Year Plan. In the future, we should continue to expand production capacity, and it is especially important that the range of domestically produced components be expanded and that product costs be lowered. Some designing should achieve domestic production through digestion and absorption in conjunction with actual conditions within China. We should deal directly with China's rich coal resources, many coal types and large amount of low quality coal to design generators adapted to lean coal, lignite, anthracite, and poor quality coal. As for lean coal and lignite, besides changes in burners, pulverizing systems also should undergo rather substantial changes.

In addition, we also should be active in summarizing our own practical experiences and in transplanting and applying imported technologies so that both are integrated and interpenetrated to improve the design levels of original generators.

Actively achieve a situation of "one type of technology, two products" so that there is greater flexibility in arrangement of tasks and so that users have a wider range of selections.

Various forms and routes of cooperation with foreign countries can be adopted.

3. Strengthen work on complete equipment sets

1) Coal pulverizers: China formerly used mostly steel ball drum coal pulverizers and intermediate storage systems. Steel ball grinding uses a great deal of energy but it is suited to lean coal and anthracite. Although medium speed grinding uses less energy, it is not suited to hard-to-ignite coal.

2) Valves: These include safety valves in the boilers themselves, electromagnetic discharge valves, temperature and pressure reducing valves in boiler startup bypass systems, temperature reducing valves in ash blower systems, regulating valves in water temperature reduction systems and so on. Their quality levels and complete outfitting capabilities should be improved.

3) FSSS systems and their matching components: Based on electric power department demands, large-scale boilers produced in the future should be fitted with FSSS. We have imported FSSS in recent years, and according to the different needs of users, users can choose from three types of systems according to function and range of material supplies. As electronic technologies develop, users will have even greater demands for digital FSSS using microcomputers.

Besides the need for implementation of FSSS in control equipment and inspection of components, the surrounding hardware remains to be put into use. Examples include fast-closing valves in heavy oil systems, three-way valves, television monitoring of stove chamber flames, high temperature smoke probes, air gate damper actuating mechanisms and so on.

4) Water supply pumps: Foreign countries generally use variable speed pumps that permit complete regulation of water supplies. China commonly uses two-stage regulation with water supply regulation valves and pumps. This consumes large amounts of energy, involves expensive equipment and cannot provide water supply regulating valves of excellent capabilities.

5) Boiler cycling pumps: Although these have been imported, demand cannot be satisfied. Besides the need for controlled cycling, future development of supercritical generators, whether compound cycle boilers or Sulzer-type DC boilers, will require the use of cycling pumps.

6) Silencers for safety valve steam discharge systems: Strict implementation of the Environmental Protection Law will institute very high environmental noise requirements in urban areas. Urban power stations must have silencers, but China still has no specific production unit so we must organize forces to design and manufacture safe and reliable product systems that have good noise elimination good results.

4. Strengthen scientific research work

Successful perfection of domestically-produced generators and technical importing work in recent years has shifted the focus of scientific research toward integration with China's conditions, the result being that study, digestion, testing and verification of imported technologies have become the primary tasks.

We feel that under the current situation, the content of scientific research work should focus on the following three aspects:

1) Integrate with the concrete conditions of China's coal resources to study combustion techniques for all types of coal quality. Systematic laboratory analysis and semi-industrial testing should be done for all of China's coal varieties to gain an understanding of the relevant technical data and accumulate operating experience. No one else can do work in this area and we must depend mainly on ourselves to carry it out.

Lean coal and anthracite account for a substantial portion in China, which is different from the situation in the United States and Western Europe. Although China now has grasped certain burning technologies for lean coal and anthracite, problems persist in areas like combustion efficiency, the lower limit of using no oil to assist in combustion, regulation of burning and so on. We should focus on gaining an understanding of the relevant combustion characteristics of these two types of coal, and considerable attention should be given to improvements in pulverizing systems.

2) Strength and stress analysis of boiler components. Development of boiler technologies will permit basic solution of the internal problems of kettles and boilers, at which time problems in the area of dynamics will become more prominent. This is especially true of large scale generator sets and intermediate load generators. Large generators are huge and there also are major differences in thermal expansion between components. Moreover, more height means that stresses from their own weight will reach substantial levels. Because intermediate load generators must be started up frequently, undergo substantial changes in load and must be started up many times, the problem of evaluating the fatigue life of low cycles will become a prominent one. Experience over the past several years indicates that the one who is the first to grasp stress analysis techniques in boiler components also will be the first to understand the design of large scale modern boilers, and they also will lay a foundation for further development of large capacity generators in the future.

3) Boiler automation technologies. This topic can be divided into the two areas of auto-control equipment and dynamic characteristics. The former should be primarily FSSS, which is automatic control equipment that must be matched with boilers. Besides research on the simple FSSS, we also should study direct digitally-controlled system structures and applied software. In the area of research on the dynamic characteristics of boilers, we should modernize research measures and establish digital modelling systems. We should strive in the future to make it possible for manufacturing plants to provide users with recommended operational procedures for startup and variable loads and the changing curves of various parameters. This will make it possible to understand the controllability of new generators before they come into being.

As for work in the area of scientific research, besides reliance on the research institutes, institutions of higher education and manufacturing plants within this system, we also should continually strengthen cooperation with units outside the system. Progress in boiler technologies must depend on technical progress in society. This is especially true of missing disciplines and weak aspects in the system itself, which make adoption of this sort of cooperative pattern even more necessary.

As for work in the future, besides the four areas outlined above, we also should encourage metallurgical departments to solve problems with the steel used in boilers. Currently, they are unable to meet the needs for development of the boiler industry, whether in terms of product types, quality or quantity.

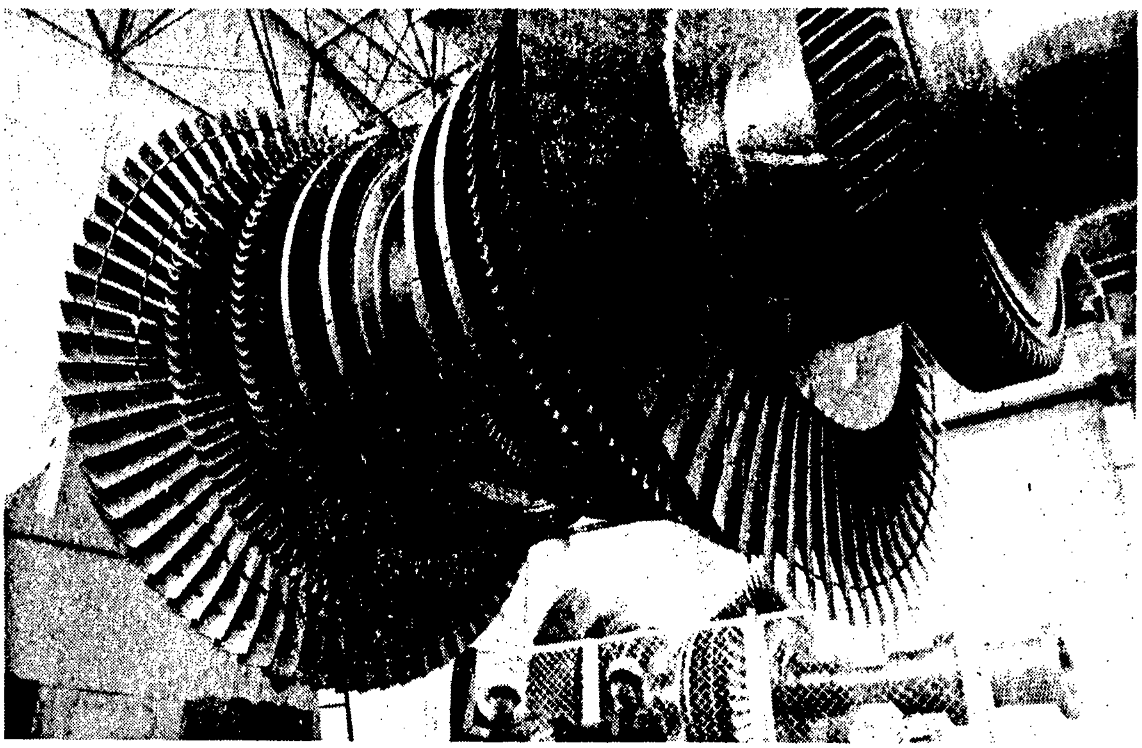
12439/9738
CSO: 4013/98

THERMAL POWER

SICHUAN PLANT TURNS OUT NATION'S BIGGEST STEAM TURBINE

Beijing RENMIN RIBAO in Chinese 11 Jun 86 p 2

[Text] [Photograph and caption]



In a united effort, the Sichuan Electrical Machinery, Steam Turbine and Boiler Works has produced China's largest single-unit (300MW) steam turbine generator. This demonstrates that China's ability to manufacture large-scale power generating equipment has reached a new level.

/7358
CSO: 4013/161

ANHUI TO TURN COAL CITY INTO 'POWER CITY'

OW111111 Beijing XINHUA in English 0650 GMT 11 Sep 86

[Text] Hefei, 11 Sep (XINHUA)--The construction of two big coal-fired power plants is well under way in Huainan City, one of China's leading coal producers, in east China's Anhui Province, according to a local official here today.

The Luohe and Pingxu power plants will have a combined generating capacity of 3.6 million kilowatts when fully completed.

Early this year, a 300,000-kilowatt generating unit was put into operation in the Luohe power plant, and another one with the same capacity is expected to be installed next month.

The Pingxu power plant is expected to complete one of its four units, each having 600,000 kilowatts in generating capacity, in the coming year.

The official said Huainan already has a power plant, the Huainan power plant, with a generating capacity of 600,000 kilowatts.

By 1988, when another 600,000-kilowatt unit is put into operation, he said, the city will have a combined power-generating capacity of 2.4 million kilowatts--enough to turn about 8 million tons of coal into 10 billion kWh of electricity a year. This will greatly ease electricity shortage in east China provinces, one of the most developed industrial areas in the country.

Huainan, which has been producing coal for more than 70 years, can now produce 10 million tons a year, and expects to raise annual output by 3 million tons in the coming 5 years.

Anhui has a verified coal reserve of 22 billion tons, and its present annual output is more than 26 million tons.

/9604
CSO: 4010/77

BRIEFS

LANZHOU 800MW PLANT--Lanzhou, 17 August (XINHUA)--Construction began Friday on the Jingyuan thermal power plant with a designed generating capacity of 800,000 kilowatts, the biggest ever built in northwest China's Gansu Province. Upon its completion in 1992, the electricity generated by the plant will constitute one-third of the province's present total, greatly easing the dry season power shortage in this economically underdeveloped province, a local official said. The official disclosed that its first power generating unit is expected to go into operation in 1988. Today, most of the electricity consumed in the province comes from hydroelectric power plants, while that generated by thermopower plants accounts only for 25 percent. [Text] [Beijing XINHUA in English 0937 GMT 17 Aug 86 OW] /12913

DALIAN BUILDS POWER PLANT--Dalian, 12 August (XINHUA)--Work started in this open coastal city today to install an up-to-date thermopower plant with a designed capacity of 1.4 million kilowatts imported from Japan. Based on an islet where a coal wharf is being built, the plant is one of China's key projects planned for the Seventh 5-Year Plan period (1986-1990). Two generating units of the first phase, each with a capacity of 350,000 kilowatts, will be installed in 1989. The plant will burn coal shipped in from Shanxi, China's leading coal producer, and use seawater for cooling and dust clearance. Electricity from the plant will be fed to Dalian and the southern part of Liaoning Province. [Text] [Beijing XINHUA in English 1354 GMT 12 Aug 86 OW] /12913

ZHANGZE ADDS GENERATOR--Taiyuan, 3 Sep (XINHUA)--With a 100,000-kilowatt capacity, the second generating unit of a coal-fired power plant in the town of Zhangze in Shanxi Province went into operation today--7 months ahead of schedule. Construction of the plant, located near the industrial city of Changzhi in one of China's main coal and chemical production centers, began in March 1984. The first generating unit went into operation 2 years later--6 months ahead of schedule. Early completion of the first two units has allowed the plant to generate 600 million kilowatt-hours more power than planners had expected, a provincial official told XINHUA today. When the plant is completed in 1990, the official said, its capacity will be 1 million kilowatts. [Text] [Beijing XINHUA in English 1423 GMT 3 Sep 86] /9604

CSO: 4010/77

TECHNOLOGICAL PROGRESS, ECONOMIC EFFECTIVENESS IN COAL INDUSTRY

Beijing SHIJIE MEITAN JISHU [WORLD COAL TECHNOLOGY] in Chinese No 6, Jun 86 pp 3-7

[Abstract of speech by Ministry of Coal Industry Vice Minister Ye Qing [0673 7230]: "Focus on Key Points, Organize Attacks on Key Technical Problems, Strive for Scientific and Technological Progress in Coal and Improvement of Economic Results"]

[Text] The Ministry of Coal Industry is responsible for three of the state's key attack projects during the Seventh Five-Year Plan. One is coal mine safety, the second is coal extraction and the third is coal conversion.

Coal is China's main primary energy resource. Coal now accounts for more than 70 percent of primary energy resources in China. According to the Seventh Five-Year Plan, raw coal output will reach 1 billion tons in 1990 including 500 million tons from unified distrubution mines.

We have implemented comprehensive contractual responsibility for tasks during the Seventh Five-Year Plan and the output indices will not be as hard to complete as financial indices. The main problems are how to base increased output on a better technological and economic foundation and how to use technological progress to make substantial improvements in economic results. This is the most prominent topic we are facing. We should focus on this care in making key attacks on technological problems. The overall guiding ideology of key attacks on technological problems is that there will be definite manpower, materials and financial problems, so we cannot "attend to each and every aspect of the matter and make comprehensive advances." Instead, we must focus on the core mentioned above and solve major problems in the following five areas. These five areas are identical to the three main projects the state has given us.

I. Coal Extraction Technologies and Equipment

The degree of mechanization in coal extraction in all of China's unified distribution coal mines was 44 percent in 1984, with comprehensive extraction accounting for one-half or 22 percent. If we use a figure of 850 million tons national output as a base figure, the degree of mechanization is only about 25 percent. This figure is far behind the major coal-producing

nations of the world. These nations basically have a degree of mechanization in extraction of more than 95 percent, with 85 to 90 percent involving comprehensive extraction. The high proportion of comprehensive extraction reduces natural disasters. This is especially true of the stronger capacity for dangerous roofs and safe conditions which are much better than in China. Therefore, we will focus on raising the degree of mechanized coal extraction and improving the results of mechanization in unified distribution coal mines during the Seventh Five-Year Plan to promote reforms and development of coal extraction technologies.

The development of mechanized coal extraction mainly requires a focus on the following areas:

The first is to focus on two key aspects: One is thick coal seams, the other is thin coal seams.

First of all, thick coal seams require equipment sets with a total extraction height of 4.5 meters to solve the problem of separate seam extraction in thick coal seams. Based on changes in the thickness of thick coal seams that lead to a situation of complex extraction procedures or loss of coal, our second key topic in thick coal seams will be extraction methods for use in opening roof-lights in thick coal seams. China has just begun using this method. China's first equipment set with an extraction height of 4.5 meters was tested by the Xishan Coal Mine Bureau in 1984. The test was successful, but many problems persist. The first equipment designed and manufactured in China for opening roof-lights to extract thick coal seams is being tested at Shenbei. Recently, another set of equipment for roof-light opening matched with fine jets will be tested underground at Hebi. We also are preparing to import a set of roof-light opening equipment from England's (Daoti) Company. To summarize, our principle is to import small amounts and integrate with our own technical forces for digestion to make a basic attack on this topic during the Seventh 5-Year Plan.

The difficulties in extraction of thin coal seams is most evident in thin coal seams less than 1.1 meters thick. Internationally, extraction of thin coal seams at present is done mainly through the following means:

1. Extraction using comprehensive extraction equipment. The Soviet Union does rather well in this area. Yearly production capacity for working faces in coal seams less than 1 meter thick can reach 500,000 tons or more. About 70 percent or less of the coal seam in the (Dunbase) Mine are less than 1 meter thick.

2. Extraction using coal planers. Third generation coal planers-drag hook taxing planers-now have appeared in West Germany and they are much improved over the two previous generations of coal planers. About 95 percent of West Germany's output from coal seams less than 1.8 meters thick is being extracted using planers at present.

3. Common mechanization in combination with pier column top shearing

This is the developmental direction of mechanized extraction in thin coal seams in China. The personnel quality demands of this method are somewhat lower and it is highly adaptable to different situations, so it is well-suited to China's national conditions.

We are still in the research and testing stage in the areas of thin coal seams and standards for mechanized equipment for use in thin coal seams. In the future, the great diversity in conditions at China's coal mines will mean that a single product line will not be sufficient to solve all of our problems, so it may be possible that we will have to develop multiple series of products.

We need to talk about the equipment question here. In the past, coal production focused on output. We only had to produce more coal and complete production plans to get by. Now, however, we must integrate output, managerial indices and investments in capital construction and assume financial responsibility for the state. There is a relationship of economic restrictions for these three items. The focus of our production, therefore, must be shifted from the quantitative to ways to produce good results on the basis of quantity and ways to convert from a production pattern to a production and administration pattern. This means that the main question in our enterprises is not to study the question of completing output quotas but instead is to study ways to achieve even better economic results on a technologically reliable foundation. This is a very obvious transition in the coal industry at present.

Because all capital is controlled by the enterprises, all consumption within an enterprise depends upon this small amount of capital, so they all want to buy inexpensive, high-quality equipment that performs well. Equipment manufactured in China is low in cost and convenient to repair, so it has become the primary focus of enterprise equipment purchases.

Most recently, relevant units in the Chinese Academy of Sciences system, the Education, Science, Culture and Public Health Committee system and the National Defense Science, Technology and Industry Commission system have wanted to participate in key attacks on technological problems and manufacturing in all sectors of production.

We first of all must affirm that we are extremely willing but we must stress one point, which is that the equipment must be competitive in manufacturing cost, quality and performance. This is a very important question that determines the ability of equipment to exist and develop. The reason is that beginning in 1986, all purchase orders will require direct links between users and manufacturers, with no interference from the Ministry of Coal Industry. We have the same attitude toward our own manufacturing industry. It must be competitive in product quality, performance and price. An enterprise must understand markets and provide good services if it is to be able to exist, and it must lower costs and produce good economic results on the foundation of guaranteed quality.

One question that we wish to emphasize during the process of making key attacks on technological problems concerns providing good complete sets of equipment. In the area of 4.5-meter full-height extraction, for example, it does not involve a single coal extractor or a single conveyor but instead emphasizes full sets of equipment to form optimum overall capacity. We require, therefore, that all industries support and cooperate with the Ministry of Coal Industry and that we can cooperate on full pieces of machinery or on parts. Most recently, many of the components in the 300 kW coal extractor designed by the Shanghai Coal Institute and manufactured by the Jixi Coal Machinery Plant were made through cooperation with outside departments. The reason is that this is one of the state's key attacks on technological problems and the State Science and Technology Commission will want to examine and except this project. Our prelimariny internal examinations indicate that this equipment is rather ideal and that a very important reason for this is that it absorbed good technologies from other industries.

The second major aspect in the development of mechanized coal extraction is a gradual development from gently sloping thick coal seams to acutely sloping coal seams at angles of less than 50 degrees.

Extraction of acutely sloping coal seams is not merely a question of raising output but also involves the use of mechanized extraction to deal with safety problems in thess seams. This must be resolved during the Seventh Five-Year Plan, and it is possible that it may be solved in the short term, so the sooner the better. We should be doing research as well as starting to import small amounts of some types of equipment. A set of equipment imported from England's (Jilike) Company is being tested at Kailuan. Preparations are underway for testing a set of equipment imported from Poland by Sichuan's Nantong Mining Bureau. China's scientific research systems also are designing prototypes in this area.

The third major aspect in the development of mechanized coal extraction is the need to deal with localized roof breaks during the extraction process. Roof breaks are a very serious problem that directly threaten coal extraction technologies. Localized roof consolidation is being tested now that will permit rather rapid progress along coal extraction work faces within a relatively short setting time.

Besides these main factors, there also are other single items like how to protect tunnels and reform traditional single long-wall extraction techniques following reforms in coal extraction technologies; how to deal with dust during the extraction process following updating up extraction techniques and equipment and so on. All of these are closely related to key attacks on technological problems.

In the area of coal extraction techniques, besides traditional techniques in China, we also are preparing to import short-wall extraction technologies and we are engaged in research in the following areas:

1. Importing and digesting short-wall extraction technologies from the United States and Australia.

Extraction technologies using continuous coal extractors are being used for about 80 percent of shaft mine extraction in the United States and Australia. They are technically simple, have few auxiliary systems and are highly efficient and safe. The continuous coal extractors used for extraction in the United States and Australia usually have a productivity of 25 tons or more per miner. Australia has made technical improvements to equipment from the United States that it is using, which has corrected some of the shortcomings of U.S. technologies, mainly involving room-type mining, and improved and recovery rate. This method substantially lowers the tunnelling rate during extraction of thin coal seams and alleviates the problem of frequent replacement.

There are other technical problems that must be solved in absorption and digestion of short-wall extraction technologies. Examples include the excessive size of the full sets of equipment, how to disassemble the equipment and take it down into the shafts and so on that must be studied. These technologies are being tested in mines with coal seams 1 meter thick.

2. In areas with the proper conditions, continuous coal extractors should be used for the new shaft construction to lower investments per ton of coal.

We are preparing to open a small 700,000-ton mine with surface systems for all of the shafts installed directly as permanent facilities. Some of the original equipment will be used and there will be contractual responsibility for investments per ton of coal. The plan is to begin construction on 1 April 1986 and to strive to complete it by 1 April 1987.

3. Ground surface protection experiments should be carried out in East China.

Rural areas of East China are rather densely populated, so resettlement of large numbers of people costs too much and it would be hard to solve problems of the peasants' livelihhod. We are, therefore, preparing to use continuous coal extractors to achieve a basic solution to the problem of surface destruction. Experiments with this equipment are being carried out at Huaibei.

4. Experimental supplementary extraction of the remaining coal in areas with complex geological structures where extraction already has been done.

Examples include areas between 20-to 30-meter faults where preparations are underway to use continuous coal extractors. Tests in preparation for this project are underway at Xuzhou.

The plan, therefore, is to test equipment, mainly continuous coal extractors, in different types of regions during 1986 and gradually shift from mainly long-wall extraction methods to integrated long-wall and short-wall extraction methods.

II. Tunnelling Technologies and Equipment

In unified distribution coal mines, the rate of development in mechanized coal extraction has been much faster that the rate of development in mechanized tunnelling, which has made it impossible for production preparation work to keep pace with the demand for a high rate of development of comprehensive mechanization. For this reason, maintaining a rational relationship between coal extraction and tunnelling, establishing mechanized tunnelling systems and updating and replacing tunnelling equipment is a very important prerequisite for accelerating development of the coal industry. In a certain sense, the significance of improvements in mechanized tunnelling are no less important or are even more important than mechanized coal extraction.

We have imported several tunneller systems of this sort:

1. We have worked through technical and trade cooperation with Austria to import AM50 tunneller systems. We are preparing to expand these systems into AM50, 75 and 100 models. Experience in their utilization in China over the past few years indicates that the results of tunnelling in half-coal and half-rock tunnels is rather good, with a monthly progress rate of 600 meters.

2. We have worked through technical and trade cooperation with Japan to import S system tunnellers and we now have two types, the S50 and the S100.

3. We have imported the Anderson RH25 system high-pressure fine jet tunnellers from England and prototype testing at present is rather good. They are characterized by mainly machine cutting with auxiliary high-pressure fine jets that solve the dust problem rather well.

During the process of achieving mechanized tunnelling, we must place our main focus on the following points:

1. Absorb and digest imported things and decide upon China's half-coal half-rock tunneller systems based on the situation in our coal mines. We already have the EL system.

2. We have developed a 3.2-meter diameter all-rock tunneller and another 5-meter diameter model now is being manufactured and soon will undergo industrial testing. This sort of tunneller probably will not be used very much in coal mines, mainly because of economic results. We are preparing to examine and verify its utilization conditions and are actively making continual improvements during practice.

3. Single machine working lines should predominate in rock tunnels. This involves using hydraulic drill rigs to drill the rock that can be installed on various types of equipment. The results have been rather good in using side-dumping rock loaders trailed by loaders and conveyor equipment to form a working line.

4. Focus on back-shafts in the area of tunnel drilling. Imported back-shaft drilling equipment includes a 100 meter back-shaft drilling rig from the Soviet Union with a back-shaft height of 100 meters and a diameter of about 1 meter and an up-and-down drill rig from Japan that is about 3 meters in diameter and can reach depths of 100 meters.

During the Seventh Five-Year Plan, we also should begin to study the question of integrating high-pressure fine jets with tunnelling machinery. The first thing is to solve the dust problem and the second is to deal with auxiliary cutting.

III. Auxiliary Mining Equipment

During the Seventh Five-Year Plan, one important key technical problem to be solved is the mechanization of auxiliary mining systems to improve overall mine efficiency. If we compare China today with foreign countries, there is not a major difference in primary production systems like winches, skips, loading equipment and so on. In the area of work faces as represented by comprehensive extraction work faces, the difference also is not rather great. Most of our current comprehensive extraction equipment is mainly third-generation equipment made in the primary coal-producing countries. But why is our full-staff efficiency so low? There are of course many reasons, one very important one being the failure to deal with continuous links between main production procedures. There are a large number of procedures that demand intense labor and take up a lot of manpower. This is especially true of the increased weight of each peice of equipment following higher levels of mechanization. Often, more than 10 winches must be installed to move the equipment from the parking lot to the work face, which requires a large number of people and involves a large number of unsafe elements. We should, therefore, organize whole systems into several links and mechanize each link to enable them to be continuous and in the end attain the goal of higher efficiency and smaller investments.

There is another important aspect of auxiliary systems which concerns modernization of management and applying modernized measures in management work. The first step is to think about using computers to improve the quality and efficiency of management.

Kailuan has done quite well in this area. It has entrusted the Chinese Academy of Sciences Computer Institute with all aspects of computer management from program design, equipment model selection, software development and hardware protection all the way to the training of computer technicians. This large mine has implemented single level management using a medium-sized

IBM 4318-II computer and all units have terminal connections. If this experiment is successful, there can be a substantial reduction in management personnel, which will lead to further improvements in the level of management.

China's coal system as a whole has a national communications plan and a national computer plan, and these two plans are interlinked. The next step requires us to find ways to integrate computers and communications systems at the surface with underground production monitoring, control and communications systems.

IV. Coal Mine Safety

There should be a basic turn for the better in coal mine safety during the Seventh Five-Year Plan and we must expend a great deal of effort to achieve it. We still have not succeeded in eliminating several vicious accidents. Gas explosions or combined gas and coal dust explosions, underground fires and large amounts of water leakage are the main problems in coal mine safety. We should focus on the following areas to deal with them:

1. Solve problems in gas forecasting and control, especially with techniques of extremely difficult discharging and discharging within the same coal seam. The main problem in gas forecasting is prominent forecasting and many areas still depend on experience.

2. Spontaneous combustion of coal. The main problem is to deal with the short cycle of spontaneous combustion. We have done some experiments in this area and imported some equipment and technologies.

3. Flood prevention. The most dangerous water disaster affecting coal mines is the water in hidden dissolved limestone caverns. A major leakage occurred at Kailuan in 1984 because of the collapse of pillar structures and linkage with a hidden dissolved limestone cavern. Because our testing measures are inadequate, the method used at present to prevent them is to integrate drainage and fill with extraction under pressure. A company in the United States has an earth current instrument that uses space technologies for making forecasts in shafts while at the surface. The level of precision is rather high and it apparently is useful to depths of 6,000 meters. The cost of renting it is rather high, however. We must deal first with forecasting and later with control.

Another problem related to safety is the prevention of occupational diseases.

The above problems are the main ones we must solve in coal mine safety. There are, of course, others like safety problems with roofs, conveyors and other areas, but the development of supporting reforms and improvements in the degree of mechanized extraction and tunnelling will provide the financial guarantees that the safety problems caused by roofs and conveyors can be focused on and solved.

V. Coal Burning and Conversion

The major portion of China's primary energy resources comes from coal and this situation will continue for a substantial period of time into the future. The main users of coal at present are electrical power, metallurgy, communications, the chemical industry and civilian users. The main problems caused by burning coal are a low rate of thermal energy utilization and environmental pollution.

There are many problems in this area and one current problem concerns the utilization of low heat value coal gangue. The heat output of washed gangue from coal dressing at present basically is 1,500 to 2,000 kilocalories, and we have substantial reserves of it. China has an electrical power shortage and the amount of electricity required to extract a ton of coal has risen gradually, so we established a gangue-burning power plant rather early to carry out experiments. The combustion furnace systems range from 35 to 130 tons and carry electrical generators ranging from 3,000 to 25,000 kW. As a result, we must deal with low heat value combustion and the corresponding equipment and technologies, and we also must solve problems of environmental protection and boiler slag utilization. At present, we basically use slag to make construction materials, so we should develop matching equipment and technologies.

The second problem concerns accelerated commercialization of coal-water mixture [CWM]. The first step is to prepare for storage and transmission of CWM and gradual conversion of some oil-burning furnaces. If combustion of CWM is possible and dehydration technologies are economical, then we can make additional developments in pipeline transmissions.

The third problem is the necessity for coal gasification. Vice Minister Li Peng said not long ago at the First National Environmental Protection Work Conference that solution of the urban fuel problem in the future will require us to take the road of gasification. We have done some experiments in this area and now we should combine large, medium and small scales based on actual conditions in different mines. Because large-scale gasification facilities require too much investment, China's mines should work on medium and small-scale gasification facilities. Technical and equipment systems should be formed on the basis of coal types and actual condition in each region during the Seventh Five-Year Plan.

We carried out some small-scale laboratory liquifaction experiments during the Sixth Five-Year Plan. The Ministry of Coal Industry and West Germany's Ruhr Company have signed a bilateral technical cooperation agreement for bilateral cooperation in research. The recent decline in petroleum prices, however, may change the situation, but we must continue to work on this topic as a technical reserve strength. The much greater size of coal reserves in comparison with petroleum reserves inevitably will cause coal to replace

petroleum, so we should adhere to the principle of working harder in the beginning and relaxing later as well as take the long term into consideration and complete the key attacks on technological and scientific problems for the coal industry during the Seventh Five-Year Plan.

(This article is based on a recorded speech and has not been checked and approved by the speaker. The title was added by the editor.)

12539/9738
CSO: 4013/146

WORK ON SUPPORT BASE FOR SHENMU FIELD BEGUN

OW190924 Beijing XINHUA in English 0839 GMT 19 Aug 86

[Text] Xi'an, 19 Aug (XINHUA)--Construction of support facilities for China's largest coal field has begun at Shenmu in northern Shaanxi Province.

With varified reserves of 140 billion tons of coal, the 13,000-square-kilometer coal field will be a major coal producer and source of exports during the Eighth Five-Year Plan (1991-1995), a local official said today.

So far, 300 small mines with 10,000 workers have been opened on the field. In 1985, they produced 1.1 million tons of coal.

"But once all the support systems are in, we'll be able to produce 37 million tons a year," the official said.

To accelerate development of the coal field, project managers have adopted an innovative strategy expressly approved by the State Council, China's highest governing body.

According to the strategy, local enterprises and departments, collectively owned units and privately owned businesses have been allowed to join state-owned enterprises in the project.

Among the support facilities will be new railroads, highways, a section of the [Huang He] that will be dredged to facilitate transportation, electric power plants, and postal and telecommunications facilities.

Construction began in June on a 171-kilometer railroad line from Shenmu to Baotou in Inner Mongolia. Work is expected to be completed in 1988.

And work will start in 1992 on a line from Shenmu to Shuoxian in Shaanxi Province. When completed, it will link up with other lines to carry Shenmu coal to Qinhuangdao harbor in Hebei Province for export.

/12624
CSO: 4010/72

BIG STRIP OPERATIONS SEEN EASING SHORTAGES IN NORTHEAST

Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 21 July 86 p 1

[Text] Coal production in northeast China will increase more than 40 million tons in the next 5 years, reaching a total of 140 million tons and gradually making the region self-sufficient in coal.

In the last few years the northeast region has had to bring in more than 20 million tons of coal annually from Shanxi and other provinces. This has not only created serious difficulties with regard to rail transport, it also has exacerbated the tight energy situation in eastern China. Accordingly, how the northeast region accelerates coal development is still a crucial issue in the region's economic development strategy.

Coal deposits exceeding 63 billion tons have already been verified in the northeast, of which 40 billion are in the eastern part of Inner Mongolia.

In January 1983 the Northeast Mongolia Coal Industry Joint Company was formally established and the plan for the development of coal resources formulated. The coal development plan will focus on eastern Heilongjiang, eastern Jilin, central Liaoning, and eastern Inner Mongolia. In addition, there will be systematic and planned development of the three large open pit mines at Yiminhe, Huolinhe, and Yuanbaoshan.

Construction of 18 new mines with a total designed capacity of 32 million tons will be be started during the period of the Seventh Five-Year Plan (1986-1990). At the same time, 19 new mines will be completed and go into production, boosting coal production capacity by more than 22 million tons, and 26 remodeled and expanded mines will also go into production, adding another 20 million tons of production capacity. The open pit mines at Huolinhe and Yiminhe have already started partial production, respectively producing 2 million and 1 million tons of raw coal a year. Before 1990, the production capacity of these two mines will be expanded respectively to 6 million and 4 million tons of coal annually.

The first phase of the construction of the Yuanbaoshan open pit mine--which will produce 5 million tons of coal annually--is scheduled to start in 1987, with the mine going into production in 1991.

CSO: 4013/167

COAL

DEVELOPMENT OF CLEANER COAL BASED FUELS URGED

Beijing MEITAN KEXUE JISHU [COAL SCIENCE AND TECHNOLOGY] in Chinese 25 Jul 85 p 7

[Article by Fan Weitang [5400 4850 0781], president of the Coal Science Academy and Chinese co-chairman of the Sino-American Symposium on "Clean Coal-Based Fuels": "Develop Clean Coal-Based Fuels, Conserve Energy, Protect the Environment"]

[Text] Coal is China's primary energy resource, accounting for more than 90 percent of recoverable reserves of combustible mineral products and more than 70 percent of the structure of energy consumption. China produces more than 700 million tons of coal each year, over 84 percent of it burned directly. Not only are thermal energy utilization rates low, but large amounts of SO_2, fly ash, and so on are discharged into the atmosphere, which seriously pollutes the environment. The degree of atmospheric pollution in China's cities compared with the technologically advanced nations of the world is such that we have 8 times more suspended microparticulates, 1 to 5 times more SO_2 and 2.2 times more CO. Acid rain has appeared in some regions and cities with serious effects on the environment and ecological balance. This makes conversion of coal into clean coal-based fuels an important problem to be solved. All nations of the world now are extremely concerned with the development of clean coal-based fuels, energy conservation, and environmental protection. The Sino-American Academic Symposium on Clean Coal-Based Fuels exchanged experiences concerning coal desulphurization and technologies for the conversion of coal into methanol fuels, and it will play a motivating role in further development of clean coal-based fuels in China and growing international scientific and technical cooperation.

Petroleum gradually has replaced coal as the primary energy resource in some nations over the past several decades. The reason is that petroleum is more convenient and cleaner than coal. Now and for several decades into the future, mankind will be faced with depletion of petroleum resources, which makes the processing of coal into convenient and clean energy resources something that all nations of the world must become greatly concerned with.

The development of clean coal-based fuels involves processing raw coal to transform it into a high efficiency, convenient, and clean modern fuel. Solid coal-based fuels are produced by dressing, dry distillation, physiochemical

desulphurization, and other processes to make solid clean fuels. Liquid coal-based fuels are made by processing raw coal through direct and indirect liquefaction, dry distillation and coal-water and coal-oil mixtures to make liquid clean fuels. Gaseous coal-based fuels involve the gassification of raw coal to produce high and medium heat value fuel gas and low heat value synthetic gas. Sulphur is the main harmful element in coal. According to preliminary estimates, China discharges as much as 14 million tons of SO_2 into the atmosphere each year. Sulphur also is a harmful impurity in coking coal. The sulphur content of coal used in the iron and steel industry is 0.1 percent per liter. A 1.2 to 2.0 percent increase in the coke content per liter lowers steel output by 2 percent. High-sulphur coal accounts for a considerable proportion of China's coal resources. The overall trend is for northern coal to have a lower sulphur content and the south a higher one. The development of new mines and greater depths in old ones will lead to a gradual rise in output of high-sulphur coal in the future.

To deal comprehensively with environmental pollution from SO_2, besides popularizing the use of clean coal-based fuels, attention also should be given to sulphur fixation during combustion and to desulphurization of flue gas. A focus on the concept of application indicates that the most effective measure at present is to use dressing methods to remove inorganic sulphur from coal. Examples include the jigging method to remove concretionary pyrite and floatation, tables and hydrodielectric swirlers to remove pyrite when it is inlaid as fine granules. Desulphurization efficiency can be as high as 40 percent under normal conditions. At the Nantong Coal Dressing Plant in Sichuan, for example, the sulphur content of raw coal averages 3.35 percent. This can be reduced to 1.5 percent after dressing and desulphurization. The desulphurization efficiency is 55 percent and pyrite can be extracted during it. Rather good economic results have been obtained in the past. Organic sulphur cannot be removed by dressing coal, so some foreign countries have developed dozens of chemical desulphurization methods. China started this work rather late, but we have done quite a bit in the area of microwave desulphurization and obtained definite results. Five reports presented at the Sino-American Scientific and Technical Symposium on Clean Coal-Based Fuels concerned desulphurization and they were welcomed by the discussants. They are being presented as references for all readers in this journal. The development of clean coal-based fuels often is considered to be expensive and is treated as a long-term topic that cannot provide results in the short-term. The actual situation in China, however, is that coal is our primary energy resource, so we must solve the pollution problems it causes. Comrade Chen Yun [7115 0061] has pointed out that "we must be concerned with environmental protection. The money must be spent, and it is better spent now than later." Development of clean coal-based fuels can provide basic results in eliminating pollution and protecting the environment. This topic, which is of strategic significance, must be given the high degree of attention it deserves.

12,539/9599
CSO: 4013/115

COAL

NEW DRESSING PLANT COMPLETED IN YINCHUAN

OW011548 Beijing XINHUA in English 1531 GMT 1 Sep 86

[Text] Yinchuan, 1 Sep (XINHUA)--A plant designed to wash Taixi coal, China's major export product, has been completed and put into operation today.

This is China's first coal-washing project specially designed for Taixi coal, a highly efficient coal noted for its low ash, sulphur, and phosphorous content.

The new coal-washing plant has an annual handling capacity of 2.1 million tons. All its processes are automatically controlled and the coal washed has five grades, with ash content kept below 5 percent.

The completion of the plant is believed to go a long way to promote China's export of such coal.

Work on the plant began in September 1983 and it cost U.S.$17.8 million.

China exports Taixi coal to more than 30 countries and regions including Belgium, Britain, Canada, France, Japan, Italy, the Philippines, Thailand, and Hong Kong.

It was learned that another such plant of similar size will be built to meet the rising international demand.

/9604
CSO: 4010/76

DISTRIBUTION OF COAL SULPHUR CONTENT STUDIED

Beijing MEITAN KEXUE JISHU [COAL AND SCIENCE AND TECHNOLOGY] in Chinese 25 Jul 85 pp 8-12

[Article by Lui Yingjie [0491 5391 2638], Chen Peng [7115 7720], Yuan Jiayuan [5913 1367 3293], Tong Xiai [0104 6932 1947], and Chen Wenmin [7115 2429 2404]: "Research on the Distributional Characteristics of Sulphur in Chinese Coal"]

[Text] China has rather substantial reserves of high-sulphur coal. Extraction during coal field development usually proceeds first in shallow coal seams and low-sulphur coal seams, but the continual increase in the amount of demand for coal generated by rapid industrial and agricultural development has meant that many mines have shifted to extraction of high-sulphur coal seams in deep strata. This is especially true of coal-short regions in southern China, where high-sulphur coal accounts for a substantial proportion of extraction. The result has been a steady increase in the sulphur content of the coal produced in China each year, and the SO_2 produced by burning coal is causing increasingly greater damage to the environment. Estimates indicate that more than 100 million tons of coal with a sulphur content greater than 2 percent is produced in China each year. According to survey calculations made by environmental protection departments, China discharges more than 18 million tons of SO_2 into the atmosphere each year, about 80 percent of it produced by coal. Acid rain is common in more than 20 cities like Chongqing, Guiyang, Guilin, and other high-sulphur coal burning cities in southern China. The problem is especially acute in Chongqing, where the pH of the acid rain is about 3.0. Continual increases in utilization of high-sulphur coal and dressed gangue in the future will cause even greater amounts of SO_2 to be discharged into the atmosphere. For this reason, an examination of the distributional characteristics and endowments of sulphur in China's coal is of extremely great and real significance for rational utilization of coal resources and the recovery of pyrite in coal series, as well as for preventing and reducing pollution of the atmosphere by sulphur in coal.

I. The Distributional Characteristics of Sulphur in the Coal of Different Areas of China

There are enormous differences in the sulphur content of coal from different areas in China. The average sulphur content of coal in different regions ranges from a minimum of about 0.2 percent to a maximum of more than 8 percent. In Heilongjiang Province in northeast China, for example, the average sulphur content of coal in many mines like Jixi, Hegang, and others is as low as about 0.2 to 0.3 percent. In many mines in the south-central and southwest, however, it is common for the average sulphur content of coal to exceed 4 percent. Coal from Shangsi in Sichuan Provinces' Guangyuan County, for example, has an average sulphur content of 8.42 percent.

The distributional characteristics of the sulphur in coal from each of the major regions of China are such that the sulphur content of coal is lowest in the three provinces of the northeast and in the northeastern part of the Nei Monggol Autonomous Region, where the average sulphur content is always less than 1 percent. This is China's low-sulphur coal region. There is, however, a gradual rise in the sulphur content of the coal of this region moving from north to south. As shown in Table 1, the sulphur content is lowest in coal from the extreme north of Heilongjiang Province, where it averages only 0.25 percent. Moving southward to Jilin and Liaoning Provinces, however, the average sulphur content of coal rises to 0.66 and 1.43 percent, respectively.

Table 1. Variation in the Sulphur Content of Coal From Northeastern Provinces

Province	Number of Coal Samples	Dry Base Total Sulphur (S^{g}_{Q}) (percent) Average	Maximum	Minimum
Heilongjiang	200	0.25	0.10	0.50
Jilin	53	0.66	0.24	2.16
Liaoning	77	1.43	0.30	8.47

There also is a certain regularity in the changes in sulphur content of the coal from other major regions. In the provinces and autonomous regions of the northwest, for instance, there is a tendency for the sulphur content of coal to rise moving from the frontier provinces and autonomous regions of the northwest toward the various provinces (and autonomous regions) of the southeast. As shown in Table 2, the sulphur content of coal from northwestern China is lowest in Qinghai Province and Xinjiang Uygur Autonomous Region in the northwestern frontier, where the average sulphur content is only 0.27 and 0.61 percent, respectively. Moving southeast toward Gansu, Ningxia, and Shaanxi, the average sulphur content of coal increases to 1.11, 1.46, and 2.84 percent, respectively (Figure 1).

Table 2. The Average Sulphur Content of Coal From Northwestern Provinces and Autonomous Regions

Province or Autonomous Region	Number of Coal Samples	Dry Base Total Sulphur (S^g_Q) (percent) Average	Maximum	Minimum
Qinghai	27	0.27	0.06	1.06
Xinjiang	44	0.61	0.22	1.48
Gansu	69	1.11	0.26	3.50
Ningxia	38	1.46	0.19	6.82
Shaanxi	83	2.84	0.32	7.33

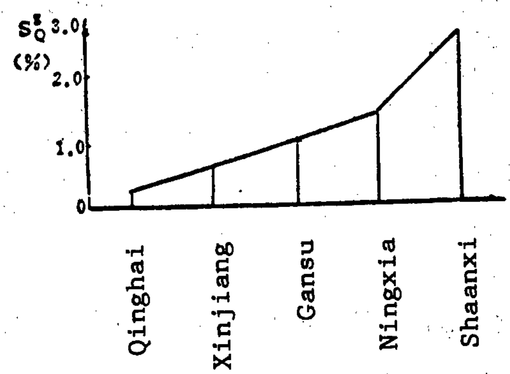


Figure 1. Average Sulphur Content of Coal From Northwestern Provinces and Autonomous Regions in China

The average sulphur content of coal is higher in eastern China than in the northwest. With the exception of coal from the Liang Huai coal fields in Anhui Province, which usually has a sulphur content less than 1 percent, the sulphur content of coal in all other provinces is higher than 1 percent. This is especially true of the coal from various coal fields in Shandong Province, where it is even higher. The maximum sulphur content of coal in the Zibo Mine, for example, is more than 10 percent.

The sulphur content of coal in south-central China is even higher than in east China. With the exception of a rather low sulphur content in most of Henan Province's coal fields, the proportion of high-sulphur coal from Guangdong, Guangxi, Hunan, and Hubei is very high. In Hubei Province, for example, more than 90 percent of the coal is high-sulphur coal with a sulphur content greater than 2 percent. Much of the coal in local mines in Hunan Province was formed during the early Permian Era, and the sulphur content almost always exceeds 4 percent. Moreover, most of it is organic sulphur, so the sulphur

content of the coal is not lowered substantially after dressing, and some of it has an even higher sulphur content than raw coal. The sulphur content exceeds 2 percent in most of the coal from the Guangxi Zhuang Autonomous Region, especially bitumenous coal, which can have a sulphur content as high as 4 to 8 percent. Moreover, the proportion of organic sulphur also is rather high. The average sulphur content of Heshan coal, for example, is 5.04 percent, but the sulphur content of cleaned coal is almost equal to that of raw coal.

In the southeast, although high-sulphur coal accounts for a rather small portion of coal from Yunnan Province, most coal from Guizhou Province is high-sulphur coal. Fairly typical of this is the coking coal from the Lizhi Mine, which has an average sulphur content of 2 to 6 percent. About three-fourths of the coal from Sichuan Province is high-sulphur coal, and the average sulphur content of most of the coal from the Nantong, Tianfu, and other coal fields is about 4 percent. The sulphur content of coal from the Xizang Autonomous Region usually ranges from 2 to 4 percent or more.

II. The Distributional Characteristics of Sulphur Content in China's Different Coal Varieties

The current classification system used for China's coal has 10 categories: lignite, long-flame coal, non-sticky coal, soft sticky coal, gas coal, rich coal, coking coal, meager coal, lean coal, and anthracite. The results of a database search on China's coal resources indicates obvious differences in the average sulphur content of the various types of coal in China (Table 3).

Table 3. Average Sulphur Content of Coal From China's Main Coal Mines

Type of Coal	Number of Coal Samples	Dry Base Total Sulphur (S_Q^g) (percent)		
		Average	Maximum	Minimum
Lignite	91	1.11	0.15	5.20
Long-flame coal	44	0.74	0.13	2.33
Non-sticky coal	17	0.89	0.12	2.51
Soft sticky coal	139	1.20	0.08	5.81
Gas coal	554	0.78	0.10	10.24
Rich coal	249	2.33	0.11	8.56
Coking coal	295	1.41	0.09	6.38
Meager coal	172	1.82	0.15	7.22
Lean coal	120	1.94	0.12	9.53
Anthracite	412	1.58	0.04	8.53
TOTAL	2,093	1.21	0.04	10.24

III. Distributional Regularities of the Sulphur Content of Coal From Different Geological Periods in China

China's coal resources were formed mainly during the Jurassic Period of the Mesozoic Era, the Carboniferous and Permian Periods of the late Paleozoic Era and the Tertiary Period of the Cenozoic Era. Most of the coal being extracted at present is from the Jurassic and Tertiary Periods. Very little Mesozoic Era Triassic period coal is being extracted.

The distributional characteristics of the sulphur content of coal from different eras in China are such that the average sulphur content of most of the coal in continental facies sediment coal fields is 1.5 percent and lower. The coal from land-sea interchange facies or shallow sea facies coal fields generally has a sulphur content as high as 2 to 6 percent or more. The longer that a coal field was subject to marine intrusion, the more likely it is for the sulphur content of the coal to be higher. These will be discussed in turn later.

1. The distributional regularities of the sulphur content of Tertiary coal

China's Tertiary coal fields are mainly continental facies early Tertiary coal in the north, while most of the coal in many lignite coal fields in the southern provinces of Guangdong, Guangxi, and Yunnan is late Tertiary land-sea interchange facies coal. The sulphur content of early Tertiary coal in the north, therefore, is usually less than 1 percent. Coal from Fushun, Shulan, and other mines generally has an average sulphur content of less than 0.60 percent. The average sulphur content of lignite from Xiaolongtan and other mines in Yunnan, however, usually is 1.5 percent and higher.

2. The distributional regularities of the sulphur content of Jurassic coal

Jurassic coal accounts for more than 40 percent of China's total coal reserves. Most of the coal fields formed during this period are located in parts of the northwest, northeast, and north of China. Most of the coal in Jurassic coal fields has an average sulphur content of less than 1.5 percent. In the Datong Mine, for example, the coal formed during the early and middle Jurassic has an average sulphur content of about 1 percent and generally ranges from 0.5 to 1.5 percent (Table 4). The coal from late Jurassic coal fields in the northeast like Jixi and others usually has an average sulphur content of less than 0.50 percent (Table 4).

Table 4. Sulphur Content of Coal From Different Periods at Typical Mines in China

Mine	Period of Coal Formation	Number of Coal Samples	Dry Base Total Sulphur (S_O^g) (percent) Average/Maximum/Minimum		
Xiaolongtan	Late Tertiary	14	1.74	0.42	3.75
Fushun	Early Tertiary	17	0.46	0.29	0.65
Jixi	Late Jurassic	100	0.30	0.20	0.50
Datong	Early and middle Jurassic	300	1.00	0.33	3.42
Nantong	Late Permian	15	4.42	2.67	10.62
Yangquan	Early Permian	13	0.49	0.37	0.91
Tongchuan	Late Carboniferous	35	3.30	1.31	7.33

3. The distributional regularities of the sulphur content of Carboniferous and Permian coal

Most of China's Carboniferous and Permian coal fields are located in the north, east, northwest, and other regions. Carboniferous coal series (traditionally called Taiyuan series coal series) were formed mainly in land-sea interchange facies and marine facies, and animal fossils like Brachiopods, Fusilinids, and so on are common in coal series strata. For this reason, the sulphur content of the coal may be 2 to 4 percent or higher. The average sulphur content in Carboniferous coal in Tongchuan and other mines in the northwest, for example, is 3.3 percent, and is around 3 to 5 percent in Carboniferous coal at the Zibo mine in east China. There are, however, many Carboniferous coal series coal fields like the Carboniferous coal series in the lower parts of the Datong coal field where the fact that the marine intrusion had already regressed during the period meant that the sulphur content of the coal there usually is less than 1 percent.

Because the marine intrusion had already regressed at the time, most of the early Permian coal series (traditionally called Shanxi series coal series) that formed immediately after the Carboniferous and Permian Periods are continental facies sediment coal fields. The sulphur content of the coal there usually is less than 1 percent. In the Yangquan and other coal fields of the north, for example, the average sulphur content is only 0.49 percent.

4. The distributional regularities of the sulphur content of Permian coal series in the south

Because the seawater involved in the late Permian marine intrusion in Sichuan, Guizhou, Jiangxi, and other provinces of China moved inward from the southwest, vast littoral coal fields were formed that accumulated land-sea interchange facies coal series of varying thicknesses (traditionally called the Leping coal series). As shown in Table 4, the average sulphur content of coal from this series in the Nantong Mine has a sulphur content of more than 4 percent, which is higher than the sulphur content of coal from other periods.

IV. Distributional Patterns of the Sulphur in China's Coal

It was discovered from the results of a large number of experiments that there is a certain regularity in the distributional patterns of the sulphur in China's coal. Because the sulphur in low-sulphur coal having a total sulphur content of less than 0.5 percent came mainly from the proteins in primitive plants of automorphous coal, most of the sulphur occurs in the form of organic sulphur. The proportion of sulphur from pyrite is rather small and there are only minute amounts of sulphur from sulfates. The sulphur content of coal from Jixi, Shuangyashan and other mines in the northeast, for example, usually is less than 0.5 percent, but it is common for the sulphur content of cleaned coal to be slightly higher than that of raw coal. The reason is that after the organic sulphur in the coal is dressed out, there is accumulation to a richer degree due to the decreased ash content of the coal.

For China's high-sulphur coal with a total sulphur content of more than 2 percent, most of the sulphur in the coal occurs in the form of pyrite sulphur. A small amount is organic sulphur and the sulphur content from sulfates generally does not exceed 0.2 percent. As shown in Table 5, the average sulphur content for 90 samples of high-sulphur coal from certain mines in China is 4.97 percent. This includes a 3.11 percent sulphur content from pyrite, or about 62.6 percent of total sulphur, while organic sulphur accounts for 1.73 percent or 34.8 percent of total sulphur. The average sulphur content from sulfates is 0.13 percent or only about 2.6 percent of total sulphur. There are major variations in the form that the sulphur takes in different high-sulphur coal mines. The Tianfu Mine, for example, has an average sulphur content of 3.99 percent, including 3.17 percent in the form of pyrite sulphur or about 80 percent of total sulphur (Table 5). Coal from the Heshan Mine, however, has an average sulphur content of 7.61 percent, of which 6.11 percent is organic sulphur, equal to about 80 percent of total sulphur. The pyrite sulphur content is only 1.36 percent or a little more than 17 percent of total sulphur.

Table 5. The Form Taken by Sulphur in Certain Types of High-Sulphur Coal in China

Mine	Number of Coal Samples	Average amount of each form of sulphur (percent) S^g_Q	S^g_{LT}	S^g_{LY}	S^g_{YI}
Tianfu	16	3.99	3.17	0.08	0.74
Nantong	15	4.42	2.93	0.04	1.45
Heshan	6	7.61	1.36	0.14	6.11
Changguang	6	5.06	3.01	0.21	1.84
Total for other mines	90	4.97	3.11	0.13	1.73

V. The Characteristics of Inlaid Pyrite in Some Typical High Sulphur Coal in China

We can see from the above descriptions that most of the sulphur in China's high-sulphur coals occurs in the form of pyrite sulphur. Only a small amount is mostly organic sulphur, and sulphur from sulfates always accounts for an extremely small amount. Microscopic examination indicates that the inlaid pyrite in high-sulphur coal occurs mainly in clumped, nodular, banded, impregnated, and widely scattered forms, that it was paragenetic with organic matter or acts as a filler in the pores of cells and so on. Besides the individual granules of pyrite that are easily removed through dressing, the remainder is rather difficult to dress out. The characteristics of inlaid pyrite in coal from three typcial late Carboniferous mines at Zibo, Zaozhuang, and Yangquan in the north and three typical late Permian mines at Tianfu, Songzao, and Changguang in the south is described briefly below.

1. Inlaid pyrite in coal from Zibo

There are rather large amounts of pyrite that account for 6.2 percent of the volume of coal samples, with 4.4 percent of it as individual granules in the coal. Another portion of the pyrite fills holes and cracks in organic matter. Only a small amount of the pyrite was paragenetic with the organic material, so it usually is rather easy to remove the pyrite from Zibo coal through dressing.

2. Inlaid pyrite in coal from Zaozhuang

Pyrite accounts for 1.1 percent of the volume of the coal samples. Most of it occurs in small scattered granules and as fine impregnated inlays. Very little of the pyrite exists as individual granules, so the rate of removal through dressing is rather low.

3. Inlaid pyrite in coal from Yangchuan

Pyrite accounts for 1.7 percent of the volume of the coal samples, with most of it occurring as filler in the holes and cracks of organic matter. Very little of the pyrite exists as individual granules, so a substantial portion of it can be removed using physical and mechanical dressing methods.

4. Inlaid pyrite in coal from Tianfu

The pyrite content of the coal is rather high, equal to 3.8 percent of the volume of the coal samples, with 1.6 percent in the form of individual granules and 2.1 percent as filler in the cell spaces of organic matter. Very little of the pyrite was paragenetic with the organic matter, and no impregnated pyrite was noted. Most of the pyrite in Tianfu coal is easily dressed out.

5. Inlaid pyrite in coal from Songzao

This coal contains quite a bit of pyrite, 5.8 percent by volume, about 70 percent of it in the form of individual clumps. However, there also is a small amount of fine granular pyrite and scattered inlays in the organic matter of the coal. Most of the pyrite in Songzao coal can be dressed out easily, with only a small amount of pyrite that is rather difficult to dress out.

6. Inlaid pyrite in coal from Changguang

Pyrite forms 3 percent of the coal by volume, about 60 percent of it occurring as clumps. In addition, some of the pyrite was paragenetic with the organic matter, and very small amounts of scattered pyrite were noted. Most of the pyrite in Changguang coal is easily dressed, although a small portion is hard to dress.

We can see from the above that it is relatively easy to dress out the pyrite in most of China's high-sulphur coal. In general, a higher pyrite content means greater amounts of individual pyrite granules that are easier to dress out. When making an examination under the microscope, however, one can discover that most of the pyrite in the coal from a small number of high-sulphur coal mines occurs in the form of scattered small granules and fine impregnated inlays in the organic matter, so it is rather difficult to extract it using the dressing method.

VI. Preliminary Conclusions

The results of analysis of the distributional characteristics of the sulphur content in more than 2,000 coal samples from each of the primary producing mines in China permit the following conclusions to be drawn:

1. The distributional regularities of the sulphur content in coal from different regions in China show a tendency toward an increase moving from

north to south and from west to east. The sulphur content is lowest in coal from the north, especially from the three northeastern provinces. The average sulphur content is the highest in coal from the south and especially the southwest.

2. The distribution of sulphur content in different brands of coal in China is such that, with the exception of the highest average sulphur content found in strongly-bonded rich coal, the tendency is for coal with a low degree of coalification to have a lower sulphur content while the sulphur content of highly metamorphized coal is higher.

3. The distributional regularities of the sulphur content in coal formed during different periods in China are such that the sulphur content is higher in land-sea interchange facies sediment coal from the late Carboniferous in the north and the late Permian in the south, while the sulphur content is lower in Jurassic continental facies sediment coal and early Permian and Tertiary coal in the north.

4. The forms taken by the sulphur in China's coal occurs indicate that most of the sulphur in low-sulphur coal with a total sulphur content of less than 0.5 percent is organic sulphur, while the pyrite content is rather low. In high-sulphur coal with a total sulphur content greater than 2 percent, the proportion of pyrite generally is higher while there is less organic sulphur. The ratio between the two usually is greater than 2:1.

5. Microscopic examination of some of China's high-sulphur coal indicates that the pyrite contained in the coal exists mostly in the form of individual granules, but there also is a considerable proportion of pyrite that occurs as a filler in the cell spaces of organic matter. The proportion of impregnated and scattered sulphur in high-sulphur coal is rather small. This means that most of the pyrite in China's high-sulphur coal can be eliminated after dressing.

Finally, it must be emphasized that despite China's extremely abundant coal resources and full complement of coal varieties, high-sulphur coal and especially high sulphur coking coal account for a rather large proportion. This is especially true of the tendency toward greater sulphur content as extraction proceeds in deep Carboniferous high-sulphur coal in the north, east, and other regions. To reduce atmospheric pollution from burning coal and lower the sulphur content of metallurgical coking coal, a long-term task is to continue to strengthen research in desulphurization methods.

12,539/9599
CSO: 4013/115

ANHUI OUTPUT TO REACH 60 MILLION TONS PER YEAR BY 2000

OW101032 Beijing XINHUA in English 0801 GMT 10 Sep 86

[Text] Hefei, 10 Sep (XINHUA)--Anhui Province in East China will increase its annual coal output to 35 million tons by 1990 and to 60 million tons by 2000, local officials said today.

Anhui's two major coal fields--on theoutskirts of the cities of Huaibei and Huainan--together contain more than 22 billion tons of coal, according to government geological surveys.

The province, one of China's major coal sources, produced 25 million tons in 1985.

Since 1949, the two major fields have produced 500 million tons of coal, according to a senior provincial official.

Over the past decade, the central government has spent more than 2 billion yuan (U.S.$540 million) improving the two major coal fields, the officials said.

To increase the fields' output, workers continue to drill new mines. Earlier this year, they drilled a shaft more than 415 meters deep--apparently a national record.

A group of new mines under construction will contain the most modern facilities available, including unprecedented mechanization and new ventilation, power supply and drainage systems, said the officials.

China produced 847 million tons of coal in 1985--supplying more than 70 percent of the country's generating power.

/9604
CSO: 4010/77

COAL

BRIEFS

LARGE COAL FIELD VERIFIED--Jinan, 14 August (ZHONGGUO XINWEN SHE)--A new coal field with 5 billion tons of proven deposits has been verified around Juye in southwestern Shandong Province. This is the largest coal field so far ascertained in the province. The new coal field, located in the four counties of Liangshan, Yuncheng, Juye, and Chengwu, covers an area of 1,570 square kilometers and is 80 kilometers long and 15 to 28 kilometers wide. It has 21 coal seams, 16 of which can be cut. On average, the thickness of each coal seam is 8.3 meters. The new coal field is located along the Yanzhou-Heze railway. As this can save a large amount of road-building expenses, it is worth exploiting this coal field. [Text] [Hong Kong ZHONGGUO XINWEN SHE in Chinese 1351 GMT 14 Aug 86 HK] /12913

460-MILLION-TON GANSU FIELD--Recently, a Gansu coal field geological brigade, following comprehensive analyses and calculations, has determined that the Daxiyao coal field contains reserves of some 460 million tons. The Daxiyao coal field is located on the border between Minqin County in Gansu Province and Alxa Youqi in Inner Mongolia. The field covers an area of more than 150 square kilometers, and contains coal of the mid-Jurrasic Period. There are 12 seams in the region, six or seven of which can be mined. [Text] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 15 Jul 86 p 3] /12223

EXPORT PLANS--The Ministry of Coal Industry has decided to launch "knock on the door" trade, establish a coal export sales network as quickly as possible, and be competitive by selling high quality, low-price coal. Coal exports will increase at the rapid rate of 5 million tons a year for the next 5 years. China ultimately will have the capability to export 30 million tons of coal a year, and will export 100 million tons over the next 5 years. [Text] [Beijing ZHONGGUO JIXIE BAO in Chinese 12 Aug 86 p 2] /7358

CSO: 4013/161

OIL AND GAS

FALLING PRICES BRING SLOWDOWN TO OFFSHORE EXPLORATION

OW191226 Beijing XINHUA in English 1056 GMT 19 Aug 86

[Text] Beijing, 19 August (XINHUA)--China has signed seven oil contracts in the second round of bidding with groups formed by 14 international oil companies, said an official from the China Offshore Oil Corporation today. Several more contracts are expected to be concluded with Japanese, American, British, and other companies this year, he said.

Foreign interest in Chinese oil is rising despite a glutted international oil market. "They are far-sighted and optimistic about the future of offshore oil in China," he said.

Meanwhile, more than a dozen foreign oil companies already operating in China continue to invest in offshore oil exploration, with a total investment before the end of June this year totalling 1.9 billion U.S. dollars. Altogether, seven oil rigs are operating in the Bohai, South China Sea and the southern Yellow Sea.

Japan provided China with a 35.765 billion Japanese yen (about 170 million U.S. dollars) loan this year for Bohai Sea oil development.

The official noted, however, that China's offshore oil development was slowing down as foreign companies are tightening their investment because of dwindling oil income from falling prices on the international market. China will adopt more flexible policies to encourage foreign companies to accelerate their development, said the official, adding that these policies will include exemption of royalties for oil fields with an annual output of less than seven million barrels.

China has completed more than 30,000 kilometers of seismic lines in the Bohai, South China Sea and the southern Yellow Sea, drilled 15 exploratory wells, and five oil and gas wells, including two in the Pearl River Basin.

China has discovered ten offshore oil fields, including the Chengbei oil field of the Bohai Sea which began operations last September and has already produced 700,000 barrels of crude. Another oil field, in the South China Sea, went into trial operation 7 August and is expected to produce 6.3 million to 7 million barrels a year.

Feasibility studies for developing other oil fields continue. Also, preparations are going full steam ahead for developing a natural gas field in the South China Sea with a 1,000 kilometer pipeline from Hainan Island to Shenzhen being studied. Negotiations on the sales of gas are going on and preparations for projects using the gas are also underway.

/12913
CSO: 4010/74

ADVANCES IN OIL, GAS PROSPECTING DURING 6TH FIVE-YEAR PLAN

Jiangling SHIYOU YU TIANRANQI DIZHI [OIL AND GAS GEOLOGY] in Chinese
Vol 7, No 2, Jun 86 pp 123-124

[Article by Li Gansheng [2621 1626 3932]: "China's Significant Advances in Oil and Gas Prospecting During the Sixth Five-Year Plan"]

[Text] State plans for petroleum and natural gas prospecting during the Sixth Five-Year Plan were completed and exceeded, and major progress was made in oil and gas prospecting, manifested primarily in the following areas:

I. Substantial Growth in Petroleum and Natural Gas Reserves

Some 78 new oil pools were discovered in China between 1981 and 1985. The newly added petroleum reserves were 1.5 times greater than those during the Fifth Five-Year Plan and more than 2 times greater than during the Fourth Five-Year Plan. The average annual rate of increase in reserves was 7.1 percent, more than double the rate of growth in crude oil output. This has changed the situation over several years in which growth in reserves could not keep pace with output. Of the newly discovered oil pools, 11 have petroleum reserves of more than 50 million tons. The reserves in these oil pools account for 38 percent of the newly added petroleum reserves during the Sixth Five-Year Plan.

During the Sixth Five-Year Plan, 12 new gas pools were discovered in China and the newly added natural gas reserves are four times greater than during the Fifth Five-Year Plan and equivalent to the total increase in newly added natural gas reserves over the past 30 years.

II. A Period of New Discoveries Has Appeared in Petroleum and Natural Gas Prospecting

Our improved understanding of basic geological structures of petroliferous basins and their formational mechanisms and evolutionary processes has led to continual expansion of our field of vision, extension of new technologies and continual improvements in petroleum levels. Breakthroughs were made in prospecting in composite oil and gas pools in eastern China and in exploration of overthrust fault zones in western China. A new situation in oil and gas prospecting was opened up and we entered a new period of discovery.

1. We discovered 15 rather large composite oil and gas accumulation zones (regions) with rather concentrated reserves in the five oil-bearing regions of Liaohe, Dagang, Huabei [North China], Shengli, and Zhongyuan in the Bohai Gulf Basin.

2. Exploration was begun in deep strata oil and gas pools at depths in excess of 5,000 meters in the Bohai Gulf Basin. Sinian, Cambrian, and Ordovician system ancient buried hill deep strata oil and gas pools were discovered at depths in excess of 5,000 meters in the Jizhong [Central Hebei] and Jiyang Depressions during the past 2 years, with daily crude oil output of about 300 tons and a maximum of as much as 2,000 tons from a single well. This shows that the depth of oil content in the Bohai Gulf region is much greater than original predictions, and that there are very good prospects for finding oil in a vast area from 4,000 to 5,000 meters deep.

3. Breakthroughs were made by using the research achievements of seismic stratigraphy to explore for oil in oil-generating depressions in deep basins in the Bohai Gulf region. An exploratory well with a daily output of 70 tons of crude oil was drilled in a secondary depression in the northern part of the Qikou Depression at Huanghua [in Hebei Province]. A large Sha 3 member lithologic oil pool was discovered in the Niuzhuang-Liuhu low-lying area of the Jiyang Depression, and it has been predicted that the favorable prospecting area could be as large as 150 square kilometers. An abyssal turbidity sand body covering a large area also was discovered in the southern part of the Raoyang Depression in central Hebei and a new exploratory well with an output of 80 cubic meters of petroleum was completed. These achievements have broken through the old view that no sandstone oil pools could be found in the center of oil generating depressions, and they have opened up a vast new realm for oil exploration in fault-subsidence basins in the Bohai Gulf and throughout eastern China.

4. Gratifying achievements have been made in oil and gas exploration in Carboniferous and Permian system, both in eastern and western China. Two high-output oil and gas wells with a daily output of natural gas that may reach 130,000 to 210,000 cubic meters and a maximum daily single-well condensate output of 134 cubic meters were drilled on the Wen'an Slope in the Central Hebei Depression. Three industrial oil wells were drilled in the Dawangzhuang region in the Jiyang Depression, with a maximum single well oil output of 127 tons. Daily output of 210,000 cubic meters of natural gas was obtained from the Permian system in the fault-fold zone at the western edge of the Ordos Basin. The Carboniferous system in the Ke-Wu fracture zone in the Junggar Basin has become primary oil and gas producing strata. This shows that there is a possibility that oil and gas are common in the Carboniferous and Permian systems in China.

5. It has been confirmed that the Ke-Wu fracture zone in the Junggar Basin is a large overthrust fracture composite zone of oil and gas accumulation covering an area of about 6,000 square kilometers. Four oil prospecting

realms, five suites of oil-bearing strata and various types of oil pools were discovered and they are developing in the direction of the Chepaizi region. This not only has brought new life to the Karamay oil province and opened up a major new realm for oil exploration but also is of guiding significance for petroleum in other northwestern basins.

6. After extending into the Gasikule oil pool in the Qaidam Basin, more high-yield suture oil and gas pools were discovered. One is the Shizigou structure, where daily outputs of more than 1,000 cubic meters of crude oil and 160,000 cubic meters of natural gas were obtained from the lower Tertiary system. Another is the Nanyi Shan structure, where an intense blowout was encountered during drilling at the Nan 2 well. High yields of oil and gas were obtained, with daily output of 500 cubic meters of crude oil and 500,000 cubic meters of natural gas. Analysis of the relevant data indicates that the producing strata are located in lower Tertiary sutured marl or calcareous mudstone. This result shows that this sort of suture high-yield oil and gas pool may be a new breakthrough in prospecting in the Qaidam Basin.

7. New achievements have been made in prospecting in the Tarim Basin. The Tarim Basin was a focal point of regional survey prospecting during the Sixth Five-Year Plan and 13 seismic profiles across the Taklimakan Desert were completed. A small number of exploratory wells also were drilled and many valuable new achievements were made. The upper Tertiary Miocene series Kekeya oil and gas pool was discovered in the southwestern part of the Tarim Basin, and high-yield oil and gas flows were obtained from the Shacan [Xayar parameter] 2 well in lower Paleozoic era Cambrian and Ordovician system limestone in the Yakela buried hill structure in the Northern Tarim uplift in the northern part of the basin. Interpretation of new seismic data confirms that the Manjiaer Depression in the eastern part of the Tarim Basin is mainly a Paleozoic Depression, and a group of valuable oil-reservoiring traps was discovered and confirmed, including three enormous structures covering more than 3,000 square kilometers located next to oil-generating depressions that are favorable targets in the search for large oil and gas pools.

8. A new oil province was discovered in the Erlian Basin. Eight oil-generating depressions covering an area of almost 16,000 square kilometers were discovered during seismic and exploratory drilling work in the Erlian Basin during the Sixth Five-Year Plan. Oil and gas have been observed 40 structural traps and industrial oil flows have been obtained in 16. The Aershan and Saihantala central fracture buried hill zone was discovered and three new oil-bearing zones were found in the Erennaoer central fracture buried hill structural zone and other locations. The area of proven oil content covers more than 100 square kilometers and substantial reserves have been controlled and proven.

III. New Achievements in Natural Gas Exploration

1. A succession of new discoveries have been made in Sichuan's old gas regions. One is the discovery of two large high output gas regions in

eastern Sichuan that are Carboniferous system sutured-porous high output gas pools. Gas pools also have been found at Yinpu, Wolong He, Zhangjiachang and other places, and the distributional area of this suite of strata may exceed 20,000 square kilometers. High output reef limestone was discovered in the upper Permian system and high output gas-bearing structures have been found at Bandong, Shibaozhai, Shuanglong and other places. The distributional area of this limestone suite may exceed 10,000 square kilometers. The second major discovery was the industrial gas flows obtained in the upper and lower Permian system in the Jialidong ancient uplift in western and southwestern Sichuan, which has opened up a new realm in gas exploration. The third discovery was the industrial gas flows obtained in non-structural locations in Jieshichang in southern Sichuan. These achievements indicate that the old gas-producing region of the Sichuan Basin has both sutured and porous gas pools and that gas content is not limited to structural locations but also occurs in non-structural locations, and they show the enormous potential for gas exploration.

2. Prospecting for oil in deeper locations in the Zhongyuan oil pool was accompanied by the discovery of a large new natural gas province in the Dongpu Depression. This gas field may cover more than 600 square kilometers, and good gas wells have been drilled in deep strata in the area of Wenliu, Qiaokou, and Baimiao. Gas strata also have been discovered in the Liuzhuan-Machang-Tangzhuan area. Proven reserves of natural gas are second only to Sichuan and analysis of the relevant data indicates that it may become the largest natural gas producing region in eastern China.

3. A large coal-formed gas pool, the Ya 13-1 gas pool, was discovered after drilling only three exploratory wells in the Yingge Sea region.

4. China's current largest carbon dioxide gas pool was discovered in the Huangqiao structure in the Subei [northern Jiangsu] region. The producing strata are from the Devonian, Carboniferous and Permian systems and the amount of geological reserves already controlled is more than 10 billion cubic meters. Prospective geological reserves are estimated at about 100 billion cubic meters.

In addition, natural gas reserves of industrial value have been discovered during oil prospecting in the eastern part of the Songliao Basin, the western part of the Ordos Basin, the northern part of the Bohai Gulf Basin, the Tarim Basin and other areas.

IV. Gratifying Accomplishments in Oil and Gas Prospecting on the Offshore Continental Shelf

Cooperation with foreign countries for petroleum exploration on our coastal continental shelf is China's largest cooperation project at the present time. Some 28 contracts covering more than 110,000 square kilometers have been signed with 30 petroleum companies from nine nations. Up to the end of 1985, some 240,000 kilometers of seismic lines had been completed in the five marine sedimentary basins of Beibu Gulf, Zhujiangkou [Pearl River Mouth], Bohai and southern Yellow Sea. We have been successful in

discovering and confirming more than 900 structures and traps, carrying out exploratory drilling in more than 80 traps and obtaining daily crude oil output in excess of 100 tons from 23 of them. Of these, nine are located in the Bohai Gulf, five are in Beibu Gulf and the remainder are in the Zhujiangkou Delta. Six oil and gas fields are at the research and development stage.

The situation in the Zhujiangkou Basin is especially pleasing. Very good discoveries have been made by the foreign ACT, Phillips and Esso Companies. They have drilled oil wells with a daily output of 1,900 tons and 2,000 tons and discovered oil-bearing strata more than 100 meters thick. More than 30 exploratory wells have been drilled in the vast South China Sea, with an average of one well drilled for every 4,000 square kilometers. Many important discoveries have been made and they indicate that there are extremely optimistic prospects for exploration and development. In the East China Sea basin, high-output industrial oil and gas flows were obtained in the Tertiary system in the Yuping Hu structure. Moreover, gas flows were obtained during drilling in the Longjing structure. The East China Sea basin also contains an enormously thick coal system and has very good prospects for oil and gas exploration.

12539/12858
CSO: 4013/150

OIL AND GAS

TAIWAN STRAITS GEOPHYSICAL SURVEY COMPLETED

HK110255 Beijing CHINA DAILY in English 11 Aug 86 p 3

[Article by staff reporter Zhang Chuxiong]

[Summary] Guangzhou--China has completed the first comprehensive geophysical survey of the western sea area of the Taiwan Straits, Xia Kanyuan, an official of the South China Sea Institute of Oceanography, announced here.

The survey from 10 July to 6 August was conducted by the oceanographic institutes in Guangzhou, Guangdong Province, and Fuzhou, Fujian Province, under the guidance of the Chinese Academy of Sciences. Led by the command ship, "Experiment Number Two," the three-ship fleet surveyed between latitudes 23 degrees and 27 degrees north, including estuaries of the Han Jiang in Guangdong Province, and the Long Jiang and Min Jiang in Fujian Province.

The fleet sailed 3,040 kilometers surveying earthquake signs, magnetic force, gravity, and water depth. The survey has revealed a thick deposit in the estuary of the Han Jiang, and an 80-120 kilometer-long, 40-50 kilometer-wide sedimentary basin in the Taiwan Straits from southeast of Xiamen to the Penghu Islands. There is another still bigger sedimentary basin in the middle of the straits, possibly part of the Taixi Basin, where oil has been found.

The survey will provide valuable data for future exploration of oil and gas in the western Taiwan Straits, Xia added.

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CSO: 4010/70

OIL AND GAS

DEPOSITS IN 16 NATURAL GAS FIELDS VERIFIED

OW141715 Beijing XINHUA in English 1522 GMT 14 Aug 86

[Text] Harbin, 14 Aug (XINHUA)--China has found 16 natural gas fields distributed both offshore and onshore, an expert from the Oil Industry Ministry said here today.

Each of them has a verified reserve of 5 billion cubic meters, he said.

Geological surveys show that China had an estimated 20,000 billion cubic meters of natural gas reserves, next only to the Soviet Union and the United States.

Most of the natural gas fields verified are distributed in the Sichuan Basin, the expert said, and some, each with an estimated reserve of 5 billion cubic meters, have been found in the Xinjiang Uygur Autonomous Region's Tarim Basin and in the Yinggehai Basin in the South China Sea. High-yield natural gas wells were also drilled in the Shaanxi-Gansu-Ningxia area and in the Songhua-Liaohe River Basin, the expert said.

China has planned to double its natural gas output by 1995. In the next 5 years China will focus on exploring the Sichuan Basin, the Bohai Bay area, and the Shaanxi-Gansu-Ningxia area, the expert said.

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CSO: 4010/70

OIL AND GAS

SOUTH CHINA SEA OIL FIELD BEGINS OPERATIONS

OW111102 Beijing XINHUA in English 1056 GMT 11 Aug 86

[Text] Beijing, 11 Aug (XINHUA)--An oil field producing 10,000 bbls a day went into operation last Thursday in the Beibu Gulf of the South China Sea, the China National Offshore Oil Corp. (CNOOC) announced here today.

Southwest of Weizhou Island in the northeastern part of Beibu Gulf, the Wei 10-3 oil field is the second of its kind offshore China. The first is the Chengbei oil field in the Sino-Japanese joint exploration zone in the Bohai Sea.

The oil field was found in the Sino-French contracted area in Beibu Gulf. Its main facilities, including a platform, a single-unit mooring facility and a 170,000-ton oil tanker, has a design production capacity of 30,000 bbls [a day]. Presently, six wells have been drilled, of which four are pumping oil.

The oil field will undergo 2 years' trial production before going into full operation, according to CNOOC.

The oil field is a joint undertaking of CNOOC and French, Japanese, and Norwegian partners with CNOOC sharing 51 percent.

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CSO: 4010/70

DAQING OIL FIELD CHIEF ENGINEER COMMENTS ON STABLE OUTPUT

OW06016 Beijing XINHUA in English 0007 GMT 6 Aug 86

[Text] Barbin, 6 Aug (XINHUA)--Increased numbers of wells and mechanical pumping are the secret of the stable annual output of more than 350 million bbl since 1976 in the Daqing oil field, Heilongjiang Province.

To drill what is called the "adjustment oil well" during Daqing's present high water-content period, Wang Demin, chief engineer of the oil field, said, "We have to first ascertain which oil-bearing strata already contain water and which do not, and locate strata 0.2 to 0.5 meters thick."

The oil field entered the high water-content period 6 years ago following the application of the technique of injecting water into strata at an early stage to maintain oil pressure.

This means that producing every seven barrels of crude oil now involves pumping out at least 6 cubic meters of water, Wang explained.

Wang said, "Mechanical pumping involves the use of submersible pumps, dehydration, and waste water treatment."

Daqing, which accounts for over half of China's annual crude oil output, started production in 1960. Its oil production rose at an annual average rate of 28 percent from 1960 to reach 350 million bbl in 1976.

Daqing's crude oil output rose to 385 million bbl last year. Increased output during this period is due largely to application of 624 research results, 70 of them believed to meet the highest world standards, an official said.

The oil field will maintain its present annual output of 385 million bbl for the next 10 years, the Daqing petroleum administration announced earlier this year.

Jin Yusun, deputy director of the administration, said that Daqing has institutes for research into oil field surveys and development, oil pumping technology, geophysical surveys and well-drilling technology.

Over the past few years, Daqing has introduced 3,300 sets of research equipment from abroad and put up new buildings with a total floor space of 130,000 square meters for scientific research.

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CSO: 4010/72

BRIEFS

HUABEI OUTPUT--Over the past 10 years the Huabei oil field, Hebei Province, has produced a total of 120 million tons of crude oil, second only to the Daqing and Shengli oil fields and ranking third in the country. During the same period the Huabei oil field handed more than 4.8 billion yuan in taxes and profits over to the state, thus making great contributions to the four modernizations. [Text] [Shijiazhuang Hebei Provincial Service in Mandarin 2200 GMT 1 Aug 86 SK] /12913

DAGANG INCREASES OUTPUT--Tianjin, 7 August (XINHUA)--Production of crude oil at the Dagang oil field for the first seven months of this year reached 2.22 million metric tons, up 6.1 percent compared with last year's corresponding period. Technological research has resulted in a breakthrough in improving the technique of thick oil extraction. Specially designed electric submerged pumps installed at 21 wells have brought the daily oil output form these wells to 3,000 metric tons as against 1,900 metric tons at the beginning of this year. [Summary] [Beijing XINHUA Domestic Service in Chinese 0135 GMT 7 Aug 86 OW] /12913

HENAN FIELD MAINTAINS STABLE FLOW--Zhengzhou, 19 August (XINHUA)--Henan oil field in central China's Henan Province has had a stable yield for eight years running, said an oil field official today. It has turned over 890 million yuan of its profits to the state since it went into production in 1978, totally recovering the state investment of 704 million yuan. The success of the oil field, which is expected to produce 16.8 million BBL of crude oil this year, is attributed to a series of managerial reforms, said the official. The oil field, China's eighth largest, has implemented total quality control and new management measures in planning, personnel and financial affairs, said the official. [Text] [Beijing XINHUA in English 1113 GMT 19 Aug 86 OW] /12913

GUDONG PRODUCTION--Shengli oil field has launched a "great battle" at Gudong, and after 100 days and nights of hard effort, daily oil production exceeds 11,000 tons. Gudong is situated within the city limits of Dongying in Shandong Province, where the Huang He enters Bohai Bay. Oil was first seen in July 1984. After more than a year of prospecting work, it was discovered that this area had reserves of several hundred million tons, and after Renqiu oil field, is China's largest field discovered in the past 10 years. Starting on 17 March this year, more than 30,000 construction workers took part in this "great battle" at Gudong. After 100 days, they had started more than 450 wells. Gudong's No. 59 well produces more than 1,000 tons of crude and more than 70,000 cubic meters of natural gas daily. As of 14 July, 500 wells had been opened up at Gudong. [Excerpt] [Jinan WENHUI BAO in Chinese 24 July 86 p 1] /9738

REDUCED EXPORTS--Beijing, 10 Sep (XINHUA)--China will reduce its oil exports by 2 million tons (about 14 million bbl) in the second half of this year to continue its support for OPEC's efforts to stabilize world oil prices. President of the China National Chemicals Import and Export Corporation Zheng Dunxun announced this at a news briefing held here today. He said China had already cut its oil exports by the same amount during the first 6 months of this year. [Text] [Beijing XINHUA in English 1447 GMT 10 Sep 86] /9604

XINJIANG STEAM INJECTION--Urumqi, 1 Sep (XINHUA)--Extraction of valuable thick oil by the steam injection method has officially begun in the Karamay oil field in the Xinjiang Uygur Autonomous Region, officials said today. Oil workers have been testing the method since 1984, injecting steam into the ground at a temperature of 200 degrees centigrade to force the thick oil out, they said, adding that daily output topped 7,300 barrels last month. China has verified thick oil deposits of 12.4 billion barrels, primarily in the Karamay field. According to the officials, the thick oil reservoirs in the Karamay field are unusually close to the surface--only about 200 meters underground. For that reason, they say, wells can be drilled rapidly and at comparatively low cost. So far, 189 thick oil wells have been sunk in the oil field, 152 of them with the steam injection method. Thick oil can be processed into high-quality gasoline and asphalt, which is in short supply in China. The country's thick oil output was 10.95 million barrels in 1985. [Text] [Beijing XINHUA in English 1156 GMT 1 Sep 86] /9604

CSO: 4010/77

FRANCE TO TRANSFER ADVANCED SAFETY TECHNOLOGY 'FREE OF CHARGE'

HK210426 Beijing CHINA DAILY in English 21 Jul 86 p 1

[Article by staff reporter Wu Jingshu]

[Text] Known for its "favourable record in the safe operation of nuclear power stations," France has agreed to transfer its advanced technology on the safety of nuclear projects to China "free of charge," according to a leading official of the National Nuclear Safety Administration (NNSA).

This free technology transfer forms "an essential part" of the Sino-French agreement on cooperation in the "all-embracing safety appraisal" of China's first joint venture nuclear power plant on Daya Bay in Guangdong Province, Shi Guangchang, deputy director-general of NNSA, told CHINA DAILY on Saturday.

The Sino-French agreement was the result of a recent visit to France by a Chinese safety delegation led by nuclear scientist Jiang Shengjie, director-general of NNSA. China and France signed a letter of intent on the cooperative effort in Paris in May, Shi said.

While NNSA has been made responsible for enforcing the newly-promulgated safety regulations on the siting, design, operation, and quality assurance of the Qinshan and Daya Bay nuclear power projects, "China and France have agreed to adopt the advanced and proven French safety appraisal methods at the Guangdong nuclear power plant on Daya Bay to ensure the project satisfies all safety requirements," Shi said.

"France has agreed to transfer its advanced technology on nuclear safety appraisal to China free during the systematic review on the safety of the design, construction, operation, and management of the Daya Bay project," Shi added.

France, whose Framatome Co. supplied of the two 900 MW pressurized-water nuclear reactors to be installed at Daya Bay, has been known for the favorable performance and high safety record of its 32 900 MW nuclear power plants built since 1973, all of which used the same standard design similar to the Daya Bay project, according to Lin Chengge, chief engineer of NNSA.

The Sino-French cooperation on safety appraisal will begin this winter, after the Guangdong Nuclear Power Joint Venture Co.--developer of the Daya nuclear project--submits its "preliminary safety analysis report" on the project to NNSA. The construction of the project will be formally launched only after the NNSA has issued a "construction permit," according to Shi.

Preparatory work for the construction of the Daya Bay nuclear power plant has been going on for several months. An engineering unit of the PLA South Sea Fleet has recently been commended for having moved 560,000 cubic meters of earth and 77,000 cubic meters of rock from the building site in 5 months in their contribution to the project, according to PEOPLE'S DAILY.

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CSO: 4010/70

PROGRESS OF CONSTRUCTION OF QINSHAN DETAILED

Hong Kong LIAOWANG [OUTLOOK] OVERSEAS EDITION in Chinese 7 Jul 86 pp 14-15

[Article by Meng Fanxia [1322 0416 1115]: "Qinshan Nuclear Power Plant Under Construction"]

[Text] The work site at the Qinshan Nuclear Power Plant now under construction in Zhejiang Province lies between the mountains and the sea, and it is alive with the hustle and bustle of machinery and people. The iron arms of the large cranes move 10-ton components to and fro and showers of blue sparks fly from welding torches. Structures as tall as those in Liuheta in Hangzhou City have appeared on the shores of the East China Sea.

Excavating 1 million cubic meters of earth and rock, pouring the more than 10-meter-thick concrete reactor island and the 1,800-meter-long tidal dike construction project have been completed smoothly since construction of this 300,000 kW nuclear power plant began in March 1984. Projects now under construction are the 60 meters-plus tall reactor pile containment building, construction of auxiliary buildings to hold various types of auxiliary equipment, installation of a conventional island foundation for turbine generators, water intake and drainage channels connecting with the sea and the river, and several tens of large and small civil engineering and installation projects. Chen Baozhi [7115 3615 0037], deputy director of the Qinshan Nuclear Power Plant Project said that the civil engineering tasks for this nuclear power plant should be completed by summer 1987 and that installation and testing will be completed and formal power generation initiated at the end of 1989.

I. "Please Don't Be Afraid, the Qinshan Nuclear Facility Is Safe and Reliable"

The Qinshan Nuclear Power Plant is located in Zhejiang Province's Haiyan County, 92 kilometers from Hangzhou and 126 kilometers from Shanghai. It also is quite close to Suzhou, Wuxi, and Changzhou in Jiangsu Province. What about its safety performance? Could an accident like the one at Chernobyl in the Soviet Union occur here? This reporter went to Qinshan with these questions in mind. The builders there answered: please don't worry, the Qinshan Nuclear Power Plant is safe and reliable. An engineer

involved in building the nuclear industry for more than 20 years said that the Qinshan Nuclear Power Plant and the Chernobyl Nuclear Power Station involve different equipment and designs. Their internal structures are different, as are their safety measures. The Qinshan Nuclear Power Plant employs a pressurized-water reactor, the most technically mature, most widely used and safest and most reliable in the world as proven by practice. It has three shields to prevent the escape of any radioactive materials and can effectively seal off radioactive materials within the facilities, avoiding any risk to those living in the area. Moreover, countermeasures and protection measures have been taken within the building to deal with the most extreme accident, when both ends reactor pile main pipelines are cut off, as well as with more than 30 possible types of accidents like water outages, power outages, earthquakes, lightning strikes, typhoons, tides, fire, aircraft collisions and so on, and it even provides for a worst-case scenario in which all of these things happen at the same time. There is a very large safety margin for each measure. Examples include a backup diesel generator for water and electricity supplies for the reactor pile which assures that the reactor will be supplied automatically with electricity within 12 seconds of an outage by external power sources. There are two reserve safety water systems and a sprinkler system that can inject water into the reactor pile through several channels in the event of an accident in the reactor moderation and water cooling systems to assure that the reactor is shut down safely. In the event of a problem with all of these channels and a failure by the diesel generator to produce electricity, the containment vessel also has four reserve water tanks that can inject water into the reactor using atmospheric pressure. The Qinshan region has an earthquake intensity of grade 6 but the earthquake resistance level of the reactor pile is grade 8. The large sea dike can hold back 8-meter-high tides, and the highest tide in history in this area has been 8 meters. The engineer said that the Chernobyl Nuclear Power Station, which was built several years ago in the Soviet Union, was very unsafe and used a graphite [moderated] reactor pile that has been abandoned by many nations. Its protection measures also were far less complete than those at the Qinshan Nuclear Power Plant. It did not have such key protection facilities as a containment vessel and had very few water injection systems. For this reason, the Qinshan Nuclear Power Plant is very safe in comparison with the Chernobyl Nuclear Power Station.

The reason that experts selected the Haiyan area as a site for a nuclear power plant include: alleviation of the energy resource shortage in this region; the convenient communications and transportation, which are beneficial in the shipping of equipment and construction materials; the good quality of the bedrock foundation; the low frequency and low intensity of earthquakes; and abundant water sources. Moreover, nuclear power is a "clean energy resource," which was a major reason for the selection of this site.

II. Clean Nuclear Energy

Often, when the words "nuclear power" are mentioned, people think of the atomic bomb or of radioactive pollution and treat nuclear power stations

in the same manner as the atomic bomb and other things, so it is hard for them to understand how nuclear power can be "clean." I asked the experts at the Qinshan Nuclear Power Plant to enlighten me on this point. They pointed out that nuclear power is different from an atomic bomb. An atomic bomb is composed of highly concentrated fission products and complex triggering systems. After being triggered, an uncontrollable fission reaction occurs that then creates a nuclear explosion. Nuclear power, on the other hand, uses low concentrations of fission material as fuel to carry out safely controlled continuous fission. Moreover, nuclear power stations also have a network of protection measures and strict control of the three wastes [waste gas, waste water and industrial residue]. This makes nuclear power both safe and clean. During operation, pressurized-water reactor nuclear power plants release only very minute amounts of radioactive pollution into the surrounding environment. According to measurements made in the United States, Japan and other nations, the radioactive irradiation dosage received by a person living near a nuclear power plant in 1 year is only 0.2 millirems. A person who watches television regularly, however, receives a dose of 1 millirem and the natural radiation in food gives each person a yearly dose of 30 millirems. A person who smokes 20 cigarettes a day receives 50 to 100 millirems a year and a single x-ray gives a person a dose of 70 to 100 millirems a year. Compared with a thermal power plant, a pressurized-water reactor nuclear power plant creates only one-third the amount of radioactive pollution as does a thermal power plant of equivalent scale. Thermal power plants also produce harmful materials like sulfur oxide and so on that nuclear power plants do not produce. The experts said that people's misgivings concerning nuclear power are due to the limited amount of propaganda of knowledge in this area and that additional propaganda in the future naturally will cause their fears to disappear. The history of electric power utilization was very similar. Very few people would ride the first streetcars in Shanghai even though they were free. Isn't the situation now quite amusing?

III. From "Just in Case" to "Never a Loss"

The Qinshan Nuclear Power Plant is China's first nuclear power facility. Because it is "the first," its success or failure will have definite effects on the pace of development in the nuclear power industry in China in the future. For this reason, everyone, from the central authorities down to local areas and from departments down to those working in the nuclear power industry, is extremely concerned about safety and reliability. Leaders in the CPC Central Committee including even Premier Zhou Enlai in the past and Hu Yaobang, Deng Xiaoping, Li Xiannian and Chen Yun in the present have issued specialized instructions. Zhao Ziyang, Li Peng, Hu Qili, Zhang Aiping and responsible people in Zhejiang Province and Shanghai Municipality have inspected the Qinshan construction site. According to instructions by central leaders, the guiding ideology of the Qinshan Nuclear Power Project design is to give primacy to assurances of safety and adhere to the principle of "safety first" and "quality first." They stipulate clearly that when there is a contradiction between safety or quality

considerations and other economic or technical indices, primacy should be given to safety protections. Builders of nuclear power plants also have a spirit of extremely great responsibility toward their cause and the people and are imposing high standards on themselves for "never a loss." After the accident at the Chernobyl Nuclear Power Station in the Soviet Union, information concerning every system in the Qinshan Nuclear Power Plant Project was collected daily for analysis and study. It is felt that although there are differences between the reactors at the Chernobyl Nuclear Power Station and the Qinshan Nuclear Power Plant, there are some things that can be learned. The main lesson is that greater attention should be given to safety and quality. Since the middle of May, the CPC Central Committee sent Zhang Aiping and responsible people from the Ministry of Nuclear Industry to Qinshan to inspect safety conditions. The Project Guidance Department has implemented the spirit of the instructions of CPC Central Committee leaders concerning the Qinshan Project at every level of every system. Now, safety and quality summaries surrounding every aspect of each system are being made and any unsafe factors discovered will be overcome. Other areas include a focus on establishing protection systems that assure safety and quality and setting up full-time quality inspection organs; compiling safety analysis reports and submitting them to state nuclear safety organs for examination; inviting Chinese and foreign specialists to provide advice and guidance concerning projects that are to begin; focusing on quality and safety in equipment now being manufactured or not yet manufactured and carrying out re-inspections. The elderly specialist Ouyang Yu [2962 7122 0056], who has been involved in design work in the nuclear industry for more than 30 years and who designed the Qinshan Project said that "we have shifted from 'just in case' to 'never a loss'."

IV. "China Still Designed and Built It"

The builders said very proudly that the Qinshan Nuclear Power Plant was designed and built by China through reliance on our own strengths. The project designer was the Ministry of Nuclear Industry's Shanghai Nuclear Engineering Research and Design Academy. Designers in sections concerned with power generation are from the East China Electric Power Design Academy. The civil construction and installation projects are the responsibility of the Nuclear Engineering Company under the Ministry of Nuclear Industry. The 30,000-plus pieces of equipment were manufactured mainly by several tens of well-known machinery and electrical machinery factories in Shanghai and some factories under the jurisdiction of the Ministry of Nuclear Industry. Only a small amount of equipment was ordered from foreign countries when manufacturers in China could not keep up with construction schedules. All of the equipment ordered from foreign countries, however, was manufactured according to Chinese design blueprints. All of the nuclear fuel used at the Qinshan Nuclear Power Plant will be supplied by the relevant factories in China.

A responsible person in a cadre department said that most of the 100-plus engineering and technical personnel involved with the Qinshan Nuclear Power

Plant were engaged in nuclear power construction prior to the "Cultural Revolution." The main technical cadres and technical workers in construction crews also have fought on the nuclear power battlefront for more than 20 years. They have fought north and south [throughout China] and many made enormous contributions to the first development of the nuclear industry in China, service to the military, and became China's first generation of nuclear industry experts. Now, they are working on a second development in the nuclear industry, service to civilian uses, and taking a new leap forward.

V. A Bright Future

"I heard that after the Chernobyl accident, the Soviet Union shut down more than 10 nuclear power stations. Will construction of the Qinshan Nuclear Power Plant and development of nuclear power in China be affected?" This is another question that many are concerned about. The builders of the Qinshan Nuclear Power Plant said that all of the nuclear power stations closed in the Soviet Union were graphite reactor power stations with rather poor safety performance, while another 20 pressurized water reactor power stations like the Qinshan Nuclear Power Plant continued to operate normally.

The builders stressed that world organic fuel resources are limited and that energy resource shortages are common. Nuclear power is a hopeful new energy resource. Not only will construction of the Qinshan Nuclear Power Plant not be affected in China, but the second and third construction periods remain. By training skilled people on the basis of experience gained in construction of the Qinshan Nuclear Power Plant, additional nuclear power stations will be built in east and south China in accordance with the needs of construction and state financial possibilities. Nuclear power construction at Qinshan and China's nuclear power industry are just beginning. Their prospects are extremely bright.

12539/12858
CSO: 4013/152

SHANGHAI PETROCHEMICAL COMPLEX NUCLEAR HEATING, POWER PLANT VIEWED

Chengdu HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] in Chinese Vol 7, No 2, Apr 86, pp 1-7

[Article by Guo Zuodong [6753 0155 2629], Qian Jinhui [6229 6930 6540], and Liu Jukui [0491 5112 1145]]

[Excerpts] I. Introduction

A significant fraction of all energy consumption is in the form of heat. Statistics show that in the United States, Japan, the Soviet Union, and West Germany, the energy consumed in the form of heat is roughly 40 percent, 60 percent, 60 percent, and 70 percent respectively of the total energy consumption in each country.

In China, energy consumption in the form of heat in 1980 was approximately 400 million tons of standard coal. As more industries are developed and the people's standard of living is improved, finding an economic solution to the heat supply problem will become a major technical and policy question.

In conventional power plants, an economic way to utilize heat energy is to combine the production of heat and electricity. For example, in 1980 the coal consumption per kWh of electricity at the Beijing No 1 Heating and Power Plant was 20-30 percent lower than that of a pure electric power plant. This figure was based on a small generator unit; however, the same experience is expected to apply to nuclear power plants.

In other countries, nuclear reactors have been used for heat generation for over 20 years and are now being used for both industrial and residential heat supply. According to incomplete statistics, 52 heat-producing nuclear reactors around the world are under construction or have already been completed, and 16 are in the planning stage; most of them are combined heating and electricity nuclear power plants. The Soviet Union is currently the leader in this field; it has PWR nuclear power plants in the 1000MW class supplying heat to metropolitan areas. Experience from other countries also shows that a nuclear heating and power plant is a cleaner source of energy than a coal-fired heating and power plant. For this reason, the nuclear heating and power plant is potentially an attractive source of heat supply because of its economy and cleanliness. With increasing economic development and an improved standard of living, it will play an important role in the area of industrial heat supply and residential heating.

II. Design of the Shanghai Petrochemical Complex Nuclear Heating and Power Plant

Based on the experience of other countries, Chinese authorities in 1981 suggested the possibility of replacing petroleum with nuclear fuel. To study this issue, we have initiated an effort to develop a small-scale nuclear reactor for the combined production of heat and electricity, and to use it to supply heat to petrochemical plants; specifically, we conducted a feasibility study of developing such a reactor for the Shanghai Petrochemical Complex. Based on the heating load of the Complex and the corresponding electricity output, we estimated the single reactor thermal power to be 450MW, and proceeded with the reactor design. The Shanghai Petrochemical Complex is built on the beach of Hangzhou Bay where the soil structure is very soft, and the base rock is 180 meters deep. Hangzhou Bay is a densely populated region and is also an important fishing port; the local chemical industry imposes strict requirements on the reliability and safety of the heat supply system. Furthermore, the heat supply unit must be located close to the heat load center, which considerably limits the site selection of the power plant. Because of these special requirements and the technical complexity of the nuclear heating and power plant, the feasibility issue cannot be addressed by conventional means; a preliminary design must first be carried out before conclusions can be drawn about these special problems. For this reason, a 3000 man-month effort was initiated, which included thorough investigations, overseas tours, and consultation with foreign experts. Also, special conferences were held where Chinese experts were invited to discuss problems of environmental protection, safety of the steam supply system, design specifications, foundation treatment at the plant site and equipment supply. Finally, a feasibility report was issued.

1. Design Summary

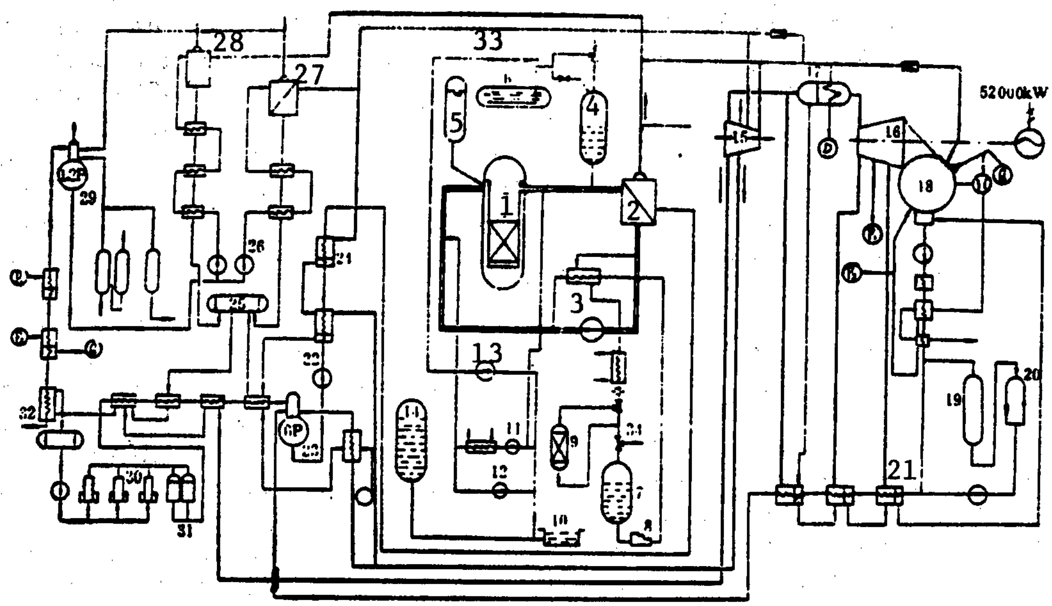
Based on China's current nuclear power technology and available information from other countries, a pressurized-water reactor (PWR) design is selected for this heating and power plant. For reasons of environmental safety, a double-layered shell structure is used to provide extra protection; a three-circuit design is selected for the steam supply system to guard against radiation hazards; also, two reactors are connected for parallel operation to ensure the reliability of the steam supply.

A flow diagram of the system is shown in Figure [1]

The heat carrying system consists of the reactors, the steam generators and the main pumps connected by the main pipes. This system has two separate circuits, each circuit contains a steam generator and a main pump; both circuits share the same pressure stabilizer. The operating pressure in the No 1 circuit is 150 kg/cm^2, the coolant flow rate is 12,000 tons/hr, the exit water temperature from the reactor is 307.5°C, and the inlet water temperature is 282.5°C. Under rated power load conditions, the steam pressure in the No 2 circuit is 50 kg/cm^2, and the temperature is 262.7°C (saturated). The temperature of the water supply from No 2 circuit is 205°C, and the steam output from each reactor is 836 tons/hr. By using the steam in the No 2 circuit as a heat source, two secondary evaporators are used to produce medium-pressure steam (35 kg/cm^2

saturated steam) at a rate of 75 tons/hr. By using intermediate bleed gas from the high-pressure tank of the steam turbine as a heat source, 15 kg/cm^2 saturated steam is produced from a heat exchanger at a rate of 320 tons/hr. In addition, each reactor is capable of generating approximately 60,000 kW of electricity.

Figure [1]. System Flow Diagram of the Nuclear Heating and Power Plant



Key:

1. reactor
2. steam generator
3. main pump
4. pressure stabilizer
5. safety injection tank
6. pressure relief tank
7. volume control tank
8. top filling pump
9. resin bed
10. safety shell pit
11. reactor shut-down cooling pump
12. safety injection pump;
13. spraying pump
14. refueling water tank
15. high-pressure turbine
16. low-pressure turbine
17. reheater for steam/water separation
18. condenser
19. hydrogen ion exchanger
20. mixing bed
21. low-pressure heater
22. main water supply pump
23. high-pressure de-oxidizer
24. high-pressure heater
25. water collection tank
26. relay pump
27. low-pressure de-oxidizer
28. medium-pressure evaporator
29. low-pressure de-oxidizer
30. electromagnetic filter
31. mixing bed
32. three-circuit auxiliary water supply
33. safety shell spray system
34. to boron return system

According to the design load factor, this proposed nuclear heating and power plant can produce 533 million kWh of electricity and 3.085×10^{12} kcal of heat annually, which is equivalent to 439,000 tons of oil. Its thermal efficiency can reach 70 percent, which is double the thermal efficiency of conventional nuclear power plants.

The reactor core has 45 17x17 standard fuel elements, which contain three different concentration levels of ^{235}U: 1.8 percent, 2.4 percent, and 3.1 percent; the equilibrium refueling concentration is 3.4 percent. Each reactor is loaded with 17.232 tons of fuel, and the refueling cycle is 300 full-power days. The average burnout is 27,000 MW.D/TU, and the maximum burnout is 43,000 MW.D/TU.

Figure [2] shows the main reactor room. The inner shell is made of steel; the inner diameter is 29 m, the cylinder wall thickness is 32 mm, the overall height is 57 m, and the net volume is 25,000 m^3. The outer shell is made of cement; its inner diameter is 31.864 m, the wall thickness is 0.7 m, and the overall height is 59 m.

Figure [3] and Figure [4] show the layout of the main and auxiliary reactor rooms of the nuclear island. It is designed so that the two reactors are located close to each other and share the same nuclear fuel depot; also, the main control room and the electric room are located above the auxiliary reactor room.

Figure 4. Main reactor room

Unit: meters

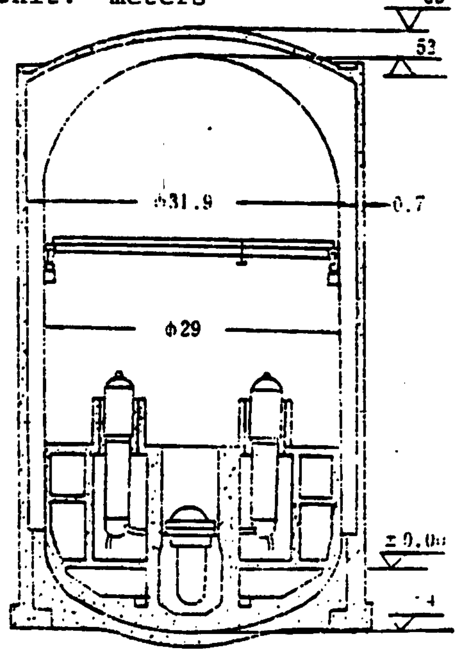
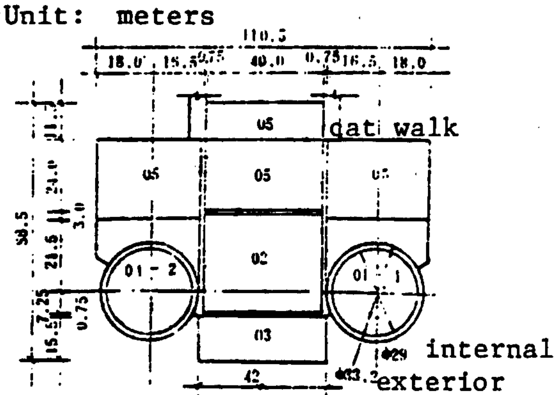


Figure 5.

Unit: meters

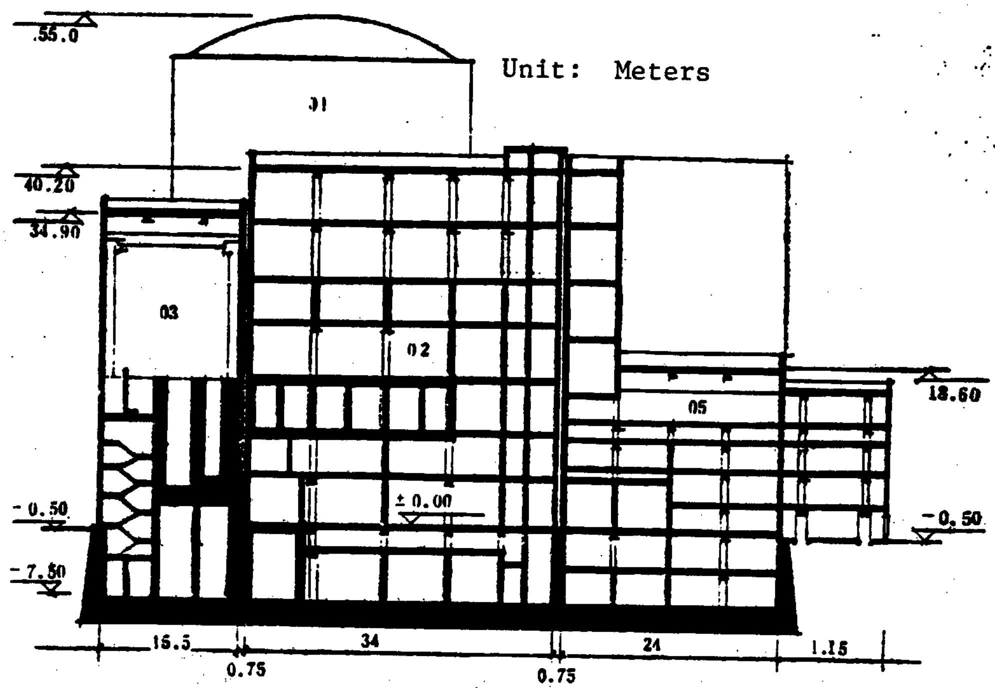


2. Design Features

(1) The Reactor is Sufficiently Safe To Be Built in a Densely Populated Region

In order to locate the reactor near heavily populated load centers while meeting the requirements of the national safety regulations, the following measures have been taken: 1) installation of the double-layered safety shell; 2) improvement of the gas removal process.

Figure [4]. Cross Sectional View of the Nuclear Island



Calculations show that it is safe to build the reactor in a residential district with a 500 m perimeter around the proposed plant site. Under normal operation, the maximum radiation dosage per person at the perimeter of the plant site is only 0.0912 millirem, which is 0.18 percent of the allowable dosage of 50 millirem specified in the national radiation protection regulation (GBJ-8-74). Even in a purely hypothetical accident where the main pipes broke at both ends, causing loss of water and reactor core melt-down, there is still no need for emergency evacuation of residents outside the perimeter of the plant. The calculations also show that under the most unfavorable weather conditions, the population dosage over a wide region 30 days after the accident is quite low. To verify this result, we have submitted the data to the U.S. Nuclear Regulatory Commission, which agreed with our calculations and considered the results to be conservative. Therefore, it is safe to conclude that building this proposed power plant in a densely populated region is consistent with current regulations.

In order to further reduce the effect of radioactive gas on the environment, we have installed a gas removal system in the No 1 circuit, and used the volume control tank for continuous gas sweeping in place of the gas removal tower of the boron return system; this leads to simpler operation and increased safety.

(2) The Reactor Control Design Leads to System Simplification and Meets Advanced Technical and Economic Standards

This reactor has 21 control rod elements, which is 47 percent of the reactor core fuel elements. They provide sufficient control capability so that regulating the boron concentration level is not required. Instead, the new

technique of rod control with boron burnout compensation is used, which greatly simplifies the system design, improves the safety, efficiency and reliability of the power plant, and also simplifies operation. The basic features of this system are as follows: A) The chemical container system is only used for compensating reactor core burnout and for achieving hot starting below the iodine pit. During steady, full-load operation, the regulating rod is removed from the reactor core to achieve more uniform power and deeper burnout. Below the iodine pit hot starting can be achieved by diluting the boron level and lifting the regulating rod without waiting for tritium decay. B) Both cold and hot starting are accomplished by rod control. Reactor shutdown or starting requires no boron regulation; it is only required for refueling or cold start. In this way, if the main steam pipe breaks, re-inserting the control rod can prevent the reactor core from returning to the critical state without emergency boron injection.

The starting operation is simpler and safer; when the temperature of the No 1 circuit rises to 100°C, because of the negative temperature coefficient, nuclear reaction can be used to accelerate the starting process, thus raising the load factor of the power plant.

The design volumes of the boron return system and the waste water system can be reduced in order to simplify the system and to reduce cost. The concentration level of the boric acid is decreased in order to eliminate the cumbersome heating system for concentrated boron.

The above control system not only can maintain uniform power distribution, it also reduces the amount of waste water discharge; consequently, the safety, economy and reliability of the power plant are improved.

(3) Higher Thermal Efficiency.

A reasonable heat to electricity ratio is selected for the power plant to achieve higher thermal efficiency. To accommodate the different heat supply loads of the Shanghai Petrochemical Complex between winter and summer, this reactor can change its operating mode so that thermal efficiency can vary from 68.7 percent to 78.9 percent; the average thermal efficiency is higher than 70 percent.

(4) Construction for Soft Soil Foundation.

After repeated comparisons and consultations with the construction departments, a pile foundation design with box support was chosen to overcome the difficulty of building on soft soil.

III. Construction Cost and Economic Considerations

Because this nuclear heating and power plant must be located near a factory, must have high safety standards, and is to be built on soft soil foundation, the construction cost is rather high. After careful discussions and reviews with the construction, assembly and equipment supply units, and taking into account various uncertain cost factors, the cost of the construction project

was estimated to be 702.35 million yuan (which includes nearly 80 million yuan for treatment of softsoil foundation). The total cost including initial fuel cost, preparation cost and design review cost will be 873.8 million yuan. This figure closely approximates the cost of building the 300 MW Qinshan nuclear power plant, and therefore is considered to be a reliable rough estimate.

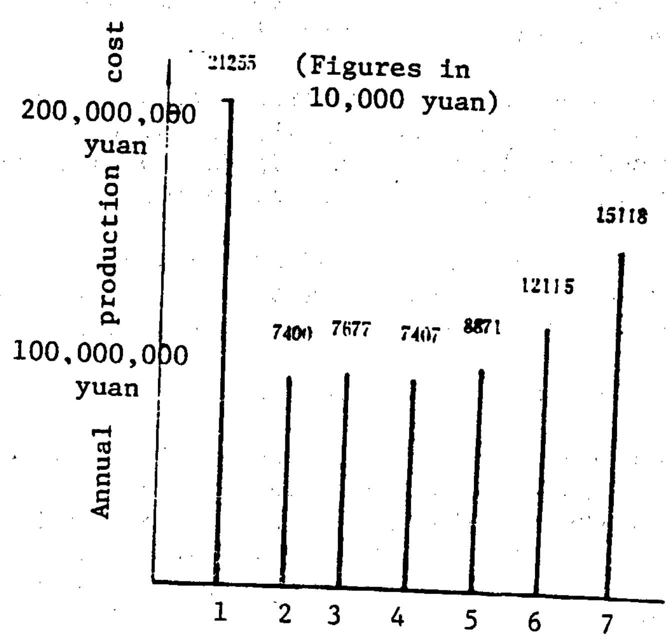
On the basis of this estimate and a 6-year construction period, we have calculated the cost of heat and electricity production based on the current interest rate and capital retrieval period. The result is compared with the costs of oil-burning and coal-burning power plants, as shown in Figure [5].

Figure [5]. Production Costs of Three Different Heating and Power Plants for the Shanghai Petrochemical Complex

Note: head supply unit production cost (yuan/kcal) x 3.085×10^{12} kcal + power generation unit production cost (yuan/kWh) x 533 million kWh.

Key:

1. oil-burning power plant with high-priced oil
2. current oil price plus tax
3. nuclear heating and power plant
4. coal-burning power plant with current coal price
5. coal-burning power plant with 1990 price level
6. coal-burning power plant with export coal price
7. coal-burning power plant with export coal price and sulfur removal



It can be seen from Figure [5] that the cost of heat and electricity production of this nuclear power plant is essentially the same as the cost based on current oil price or the equivalent heavy oil price plus oil-burning tax. But compared with the 1990 price level, there is a distinct difference because the nuclear fuel remains flat whereas coal price continues to rise. The economy of nuclear power plant is better than current coal-fired power plant if sulfur removal is included in the current coal price. The main disadvantages of the nuclear heating and power plant are the high initial construction cost, the long construction period and delayed economic payback.

IV. Key Issues for Improving Economic Benefits and Competitiveness

This nuclear heating and power plant is designed to have all the components that a large nuclear power plant has except they are smaller in size. This is

a low risk approach because only mature technology is used. But there is one serious drawback, i.e., the scale of construction has not been reduced in proportion to the reduction in reactor power. As a consequence, there are a number of adverse effects such as high construction cost, long construction period and delayed economic payback. In order to improve its competitiveness, we must try to reduce the scale of construction and increase the construction speed without sacrificing safety. A small-scale nuclear power plant can only survive if its construction cost is lower and its construction period is shorter. In this design, we have taken the following exploratory measures to achieve this goal:

1. Use of Compact Layout in Designing the Nuclear Island

It is shown that the safety shell is much smaller if a compact layout is chosen. On the basis of this design groundrule, the safety shell of this power plant can be reduced by 9 m to less than 20 m. This will result in considerable reduction of the scale of construction, and thus lower construction cost and faster construction speed.

2. System Simplification

With the nuclear island reduced in size, the system should be simplified accordingly in order to reduce the size of the auxiliary building. The previously described control technique which uses rod control with boron compensation is highly complicated. Analysis shows that on a small reactor, it is feasible to use solid poison for control without boron; but to implement this technique requires experimental verification. Eliminating the use of boron will reduce the number of valves and simplify the system; it will also reduce the amount of waste material and ultimately reduce the size of the auxiliary building. Hence this is a significant improvement.

3. Lowering the Nuclear Fuel Cost

Economic analysis shows that the price of nuclear fuel approaches a sensitivity of 60 percent in the cost structure. Therefore, another aspect of increasing the competitiveness of small nuclear heating and power plant would be to increase the accuracy of physical calculations, improve the performance and lowering the price of fuel elements.

4. Improving Quality Management

In order to ensure that the nuclear power plant will have high load factor, we must try to improve the quality management during design and construction.

An economic analysis of the Shanghai Petrochemical Complex Nuclear Heating and Power Plant shows that if the load factor decreases from 70 percent to 50 percent, then the cost of power generation and heat supply will increase by 22 percent. Therefore, an important design consideration is to try to improve the operating reliability and annual load factor of the nuclear and power plant.

5. Standardization and Other Issues

By emphasizing standardization and carrying out fabrication and assembly in the factory as much as possible, the amount of labor in the field can be minimized, thus improving quality control and increasing the speed of construction.

Through feasibility studies, we have acquired a fairly complete understanding of small-scale nuclear heating and power plants. We believe that 800 million yuan will be approximately the upper limit of the construction cost. The cost can be reduced by implementing any one of the improvement measures described above. Furthermore, this is the first nuclear heating and power plant for which all components are produced on a single-unit basis. It is expected that the construction cost will drop below 800 million yuan after a number of reactors have been built, and then such power plants will become more competitive.

3012/8918
CSO: 4008/76

450MW PWR FOR JINSHAN NUCLEAR HEAT, POWER PLANT

Chengdu HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] in Chinese Vol 7, No 2, Apr 86, pp 8-10

[Article by Shen Lubing [3088 1462 0393]]

[Text] I. Introduction

The nuclear heat and power plant of the Shanghai Petrochemical Complex is powered by a pressurized-water reactor (PWR) which uses light water for cooling and moderation. This type of reactor is the most widely constructed and operated reactor in the world; it is also a reactor with proven safety and economy. The reactor is composed of a pressure vessel, a reactor core, internal structural components and sensing devices, and drive mechanism (Figure 1). It has a maximum diameter of 3,260 mm, overall height of 13.7 m, and a dry weight of 213 tons. The design thermal power of the reactor is 450 MW, the coolant pressure is 150 kg/cm^2, the inlet temperature is 282.5°C, the exit temperature is 307.5°C, and the total flow rate is 12,000 tons/hour.

The reactor has two separate circuits: the coolant enters the pressure vessel from the inlet pipe, passes through the annular cavity between the vessel and the hanging basket, and flows down to the bottom of the vessel; then it makes a 180° turn through the flow distribution skirt and the flow distribution plate into the reactor core; carrying away the heat produced in the core, it finally flows outside through the two exit pipes. Approximately 5 percent of the total coolant flow is used to cool the cover of the pressure vessel, the heat screen of the hanging basket, and the control rod.

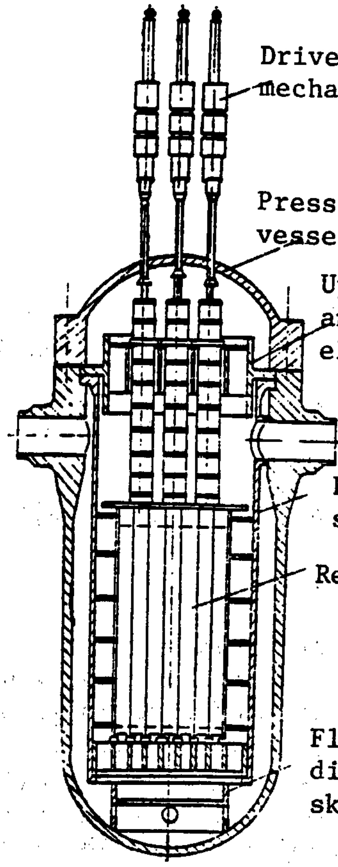
The reactor design streese safety, practical utility, economy and the use of advanced technology. Its main features are as follows:

1) Standard 17x17 fuel elements are used in order to promote compliance of Chinese-made fuel elements with international standards, and to facilitate the use of foreign technology and experience.

2) The pressure vessel is reinforced using integral pipe connections. The exit and inlet pipes are both of the seated type which has a shorter weld seam; therefore, it facilitates the manufacturing process such as welding and flaw detection.

Figure 1.

Structure of the 450MW Reactor



3) The pressure vessel has no other connecting pipes below the main coolant pipe; hence if a crack develops in the connecting pipe, the reactor core will be submerged by water from the emergency cooling system.

4) There is a large annular water cavity between the pressure vessel and the hanging basket, which is designed to keep the integrated neutron flux (E> 1MeV) inside the vessel over a 40-year period to be less than 1.61×10^{19} n/cm^2, and to provide protection against accidents due to loss of water.

5) The reactor has two safety injection tubes which extend to the lower part of the reactor core. In case of water loss, emergency water can be quickly supplied to the reactor via the safety injection tubes.

6) All support plates inside the reactor are made of welded components. The compressing spring consists of a small butterfly spring element; this design eliminates the use of bulky stainless-steel forged parts, and can be fabricated totally in this country.

7) The neutron flux in the reactor is measured by a vanadium-ball detection system.

8) Both rod-control and boron-control techniques are used to regulate the nuclear reaction; during normal operation, only rod-control is used for starting and stopping the reactor.

II. Pressure Vessel

The pressure vessel consists of two main sections: the cylindrical body and the top cover. The two sections are connected by flanges with two "O" rings in-between and pressed against one another by 44 sealing bolts. The vessel is 8284 mm tall, has a maximum diameter of 3260 mm and weighs approximately 124 tons.

The cylinder has an inner diameter of 2700 mm and a wall thickness of 135 mm; it is a welded structure consisting of a seamless forged bottom enclosure, a cylindrical shell and a cylindrical flange.

The flange has four coolant connectors and two safety injection connectors; the flange thickness satisfies the reinforcement requirement of the connectors. This integral flange design with reinforced connectors not only eliminates a main weld seam on the cylinder, but also simplifies the welding process and reduces the amount of solder flux required, thus improving the stress condition in the connector region.

The top cover consists of a forged flange welded to a spherical cap. The spherical cap has 21 connectors for the drive mechanism, 6 connectors for the sensor ports and 1 connector for the exhaust port. The reinforcement of these connector ports is accomplished by uniformly increasing the thickness of the spherical cap.

The rpessure vessel is made of fine-grain ASTMSA508-3 steel, which has very good properties under neutron radiation.

The inner surface of the pressure vessel is covered with a layer of Austenite stainless steel; the outer surface has a layer of metallic reflecting type thermal insulation.

III. Reactor Core

The reactor core consists of 45 fuel elements and 21 control rods; its equivalent diameter is 1.63 m and its height is 2.73 m. The rather large height-to-diameter ratio of 1.68 results in poor neutron efficiency, but it reduces the capacity of the main pump and the diameters of the pressure vessel and the main pipes. This design is chosen primarily in consideration of China's manufacturing capability of reactor components even though certain physical performance may be sacrificed. Calculations show however, that the average equilibrium burnup level can still reach 27,000 MW·D/TU.

The initial fuel elements of the reactor core has three concentration levels: 1.8 percent, 2.4 percent, and 3.1 percent; the equilibrium refueling concentration level is 3.4 percent. In addition, burnable poison rods made of 272B4C-Zr-2 material are installed inside the reactor so that the radial coefficient of power non-uniformity is kept below 1.499, and the axial coefficient is 1.735. After considering the effect of local power peaks and computational errors, the overall coefficient of power non-uniformity is estimated to less than 2.81. The thermodynamic design calculations show that under normal operating conditions, the minimum burnout ratio of a typical channel is 2.62, and

the maximum temperature of the core block is 1744°C; the minimum burnout ratio under 118 percent overload condition is 2.16, and the maximum temperature of the core block is 1949°C.

The reactor core has 21 control rod elements which are inserted in 47 percent of the fuel elements; they provide sufficient control capability for starting or shutting down the reactor without boron dilution or addition, thus considerably simplifying the boron return system. The control rods are divided into 2 categories: one is called the shutdown rod unit which has 13 elements separated into 3 groups S_1, S_2, S_3, all made of Ag-In-Cd absorbing material; the other is the gray-body regulating-rod unit, which has 8 elements separated into 2 groups R_1, R_2, it has 8 Ag-In-Cd rods and 16 stainless-steel rods.

The fuel elements are arranged in a standard 17x17 array, which essentially has the same structural form, dimensions and fuel concentration level as the fuel elements of the Guangdong Nuclear Power Plant imported from France; the only differences are: (1) the overall length of the elements is reduced to 3,088 mm, and the total weight is 498.8 kg; (2) the elements contain no special instrument guide tubes; (3) the enclosure material is made of annealed Zr-4 tubes rather than cold-quenched tubes, and the thickness of the enclosure shell is increased from 0.57 mm to 0.64 mm in order to imporve the reliability of the first layer safety shield.

The reactor also contains such components as the burnable poison elements, neutron source elements and flow stops.

IV. Structural Members Inside the Reactor

The structural members inside the reactor include the reactor core support structure, the upper flow guide and clamping unit, and the flow distribution skirt. Their main functions are to support and position the fuel elements, the control rods, and the sensing elements, as well as to properly guide the coolant flow inside the reactor.

The reactor core support structure weighs approximately 31 tons, stands 5,667 mm, and has a maximum diameter of 2,540 mm. The structure consists of the handing basket, the heat shield, the enclosure plate, and the lower support plate; the entire structure is suspended onto the pressure vessel flange through the flange of the hanging basket cylinder, and is properly aligned by 4 position pins. During inspection of the pressure vessel, the structure can be lifted out as a single unit.

The upper flow guide and clamping unit weighs 13.5 tons, stands 2840 mm and has a maximum diameter of 2,540 mm; it consists of 21 flow guide elements, 21 support columns, 1 upper support plate and 1 lower lattice plate. The support column not only links the upper support plate and the lower lattice plate into a single structure, it also protects the flow guide from being bombarded by the water flow; in particular, it ensures that the flow guide continue to function during a loss-of-water accident. The upper flow guide and clamping unit is attached to the flange of the hanging basket through the flange of the upper support plate, and presses tightly against the top cover of the pressure vessel.

The design of the structural members takes into account such factors as fabrication procedures, cost and domestic manufacturing capability; for example, the upper and lower support plates are made of welded frame structures instead of large forged parts, the large compressing springs are replaced by small butterfly spring units.

V. Sensing Elements Inside the Reactor

The reactor has six sensing units which include the wiring box, the finger-shaped lead-in tubes and the main lead-out tube. The wiring box contains the pneumatic-ball guide tube, thenitrogen tube and the thermocouple and electric cables, and feeds them through the main lead-out tube to the outside of the reactor; it also distributes the finger-shape lead-in tubes to the various sensor locations in the reactor core. Each sensing element may be connected to 2 or 3 lead-in tubes. A lead-in tube consists of a ball sensing tube and a thermocouple. The sensing units are located on top of the upper support plate, between the flow guide units; they can be lifted out during refueling and kept in a water container. This design greatly facilitates maintenance and repair and simplifies replacement procedure.

VI. Drive Mechanism

The drive mechanism performs the function of regulating the movement of the control rods. In this reactor, a magnetic lifting drive mechanism is used in which two locking hooks can operate the control rods through the drive linkages; the locking hooks are activated by energizing or de-energizing three excitation coils according to a preprogrammed sequence.

The mechanism includes the executive segment, the pressure bearing segment, and the position indicator. The executive segment consists of three operating coils, three magnets and armatures, the locking hooks and the drive linkages; for each magnet there is a corresponding armature. The pressure shell is located between the three coils and the three magnets; it provides a pressure boundary for coolant, and separates the mechanical from the electric segment. The position indicator is composed of an independent position indicating coil which fits over the travel tube of the drive linkages; there is a coil at each of the top and bottom end of the travel tube to indicate the position limits. The design travel of the mechanism is 2,630 mm, the step size is 10 mm, and the normal lift load is 80 kg.

3012/8918
CSO: 4008/76

BRIEFS

HEAVY WATER REACTOR TESTS--The Chinese Atomic Energy Research Institute has designed a modified experimental heavy water reactor which can carry out radiation tests on nuclear fuel and materials for nuclear power plants and other reactors, conduct irradiation studies on biological specimens, and produce radioisotopes. [Excerpt] [Tianjin JISHU SHICHANG BAO in Chinese, 15 Jul 86 p 4] /9738

CSO: 4103/153

ALTERNATIVE ENERGY CONFERENCE ENDS IN HOHHOT

OW021002 Beijing XINHUA in English 0932 GMT 2 Sep 86

[Text] Hohhot, 2 Sep (XINHUA)--China has made progress in using solar, wind, geothermal, hydroelectric, and biogenic gas energy sources to solve the rural energy shortage.

More than 15,000 wind power generators and 8,000 water pumps have been installed in northwest China, Inner Mongolia, and coastal areas over the past 6 years, said Zeng Xianlin, vice-chairman of the State Science and Technology Commission at the national energy development and application conference which closed in this capital of the Inner Mongolia Autonomous Region Sunday.

Some 40,000 biogenic gas pits, utilizing manure from farm animals, are being used by farmers for cooking. Solar energy heaters and stoves are popular in many parts of the country, said Zeng.

More than 100 of the country's 3,000 geothermal deposits are being used for irrigation, fish-raising, livestock breeding, and heating.

The Jiangxia hydroelectric power station in east China's Zhejiang Province, with a generating capacity of 3,200 kilowatts, uses tidal energy to generate 10 million kilowatt-hours a year, said Zeng.

China has three research centers for wind power, solar power and biogenic gas, and 2,000 scientists and technicians in 70 research units are engaged in the study of new energy forms.

The country will concentrate efforts on raising the level of technology and the quality of equipment used in new energy development so as to provide cheaper and better products for the countryside, said Zeng. China will work with foreign countries to import advanced technology and equipment for research.

/9604
CSO: 4010/76

LIGHT INDUSTRY MAKES IMPRESSIVE GAINS IN ENERGY CONSERVATION

Beijing ZHONGGUO QINGGONGYE BAO in Chinese 27 Apr 86 p 1

[Article: "Light Industry Conserves 10 Million Tons of Energy During the Sixth Five-Year Plan, Obvious Achievements Have Been Made in Grassroots Management"]

[Text] Light industry is a sector that consumes rather large amounts of energy resources. Consumption during the Sixth Five-Year Plan averaged 43 million tons (converted to standard coal, as below). Energy conservation and reduced consumption are of great significance for adherence to state energy conservation principles, promoting development in light industry and achieving our strategic goals by the end of this century.

Obvious accomplishments were made in energy conservation in light industry during the Sixth Five-Year Plan. Production grew substantially and the amount of energy consumed per 10,000 yuan in value of output has fallen year after year. The gross value of output completed in light industry during 1985 was 156 billion yuan, up by 66.13 percent over 1980, an average yearly rate of 10.8 percent over 5 years. Energy resource consumption during 1985 was 48.36 million tons, up by 27.2 percent over 1980 and an average yearly rate of 4.93 percent over 5 years. The elasticity coefficient of energy resource consumption was 0.46 and the amount of energy consumed per 10,000 yuan in value of output fell from 4.5 tons in 1980 to 3.34 tons in 1984. A total of 75.5 million tons of energy was conserved over the past 4 years. The predicted amount of energy consumed per 10,000 yuan in value of output for 1985 is 3.1 tons, down by 23.5 percent over a 5-year period. The total amount of energy conserved may surpass 10 million tons, an energy conservation rate of 5.21 percent. There was a visible drop in unit energy consumption in primary energy-consuming products during the Sixth Five-Year Plan. Energy consumption per ton of finished household glass products dropped from 1.3 tons to 0.6 tons, and the more advanced enterprises fell to 0.4 to 0.65 tons. Energy consumption per ton of paper and cardboard fell from 1.88 tons to 1.7 tons. Energy consumption for staple products like paper for paper bags, letterpress paper, cigarette rolling paper and so on dropped to 1.3 to 1.55 tons in advanced enterprises. The amount of energy consumed to process 100 tons of sugarcane into sugar dropped from 7.9 tons to 7.5 tons, and the figure was 4.95 to 6.24 tons in advanced enterprises. There also

was a rather substantial decline in energy consumption in shaft salt mines. Energy consumption in Sichuan Province, a large producing region, dropped from 500 kilograms of standard coal per ton of salt in 1980 to 331 kilograms, a 33.8 percent decline. The figure for advanced enterprises was 163 to 166 kilograms.

During the Sixth Five-Year Plan, we strengthened basic management work in energy conservation and carried out technical transformation to conserve energy. This played a key role in transforming the technical situation in industry and in conserving energy resources. Sichuan, for example, switched from open-hearth salt making to vacuum salt making. Additions of 500,000 tons per year in capacity were made and they also carried out "pressurized gas coal treatment" to conserve natural gas. Total installed generator capacity in heat and power cogeneration rose to about 250,000 kW, which played an important role in improving energy conservation results and alleviating the contradiction between electrical power supplies and demand. About 1,000 low-efficiency furnaces and industrial kilns were transformed during the Sixth Five-Year Plan and more than 2,000 pieces of specialized energy-saving equipment like dual disk grinding, new types of bubble sprayers and so on were put in use, which improved the standards of technical equipment.

Good achievements were made in energy engineering in light industry during the Sixth Five-Year Plan. On this basis, the plan for the Seventh Five-Year Plan is to conserve 10 million tons of energy and make new contributions to "doubling to assure quadrupling" [doubling energy resource production to assure the quadrupling of the gross value of industrial and agricultural output by the year 2000].

12539/12858
CSO: 4013/152

MORE POWER PLANTS BEING CONVERTED FROM OIL TO COAL

OW251913 Beijing XINHUA in English 1158 GMT 25 Jul 86

[Text] Beijing, 25 Jul (XINHUA)--Generating units of power plants to be converted from burning oil to coal during the Seventh Five-Year Plan (1986-90) will have an aggregate capacity of 3,000 MW, accounting for half of the country's total of such units, a Chinese energy development company announced here today.

At present, about one-third of such oil-burning generating units have been replaced by newly built coal-burning and hydroelectric units and are waiting for conversion, the Huaneng Power Generation Corporation said.

When the conversion program is completed, these generating units are expected to produce 15 billion kWh of electricity, about one-third of what China is presently short of, the corporation added.

Apart from helping save a large amount of crude oil, the conversion program requires less money and time in turning out power to alleviate the power shortage in some parts of the country, and is viewed as a short cut to boosting China's power industry.

Up until 1980, when the country began the conversion program, China's oil-burning generating units consumed some 140 million bbl of crude and heavy oil a year, causing a loss of several billion yuan.

By turning oil-burning generating units into coal-burning ones, China has saved more than 161 million bbl of crude oil in the past 5 years.

China will be able to save some 140 million bbl of oil through the same efforts by the year 1990, the energy development corporation said.

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CSO: 4010/68

CONSERVATION

BRIEFS

SIX MILLION TONS OF COAL SAVED--Beijing, 4 Sep (XINHUA)--Energy conservation measures saved China's industries 6 million tons of coal during the first half of the year, the State Statistics Bureau said today. According to the bureau, for every 100 million yuan (U.S.$27 million) of output value, China's industries used 54,300 tons of coal, 2.4 percent less than in the first half of 1985. But, said bureau officials, still more savings are possible. "We'll save a lot more coal once most of the country's industries have been retooled with contemporary technology," one official told XINHUA. "And even more can be saved by targeting manufacturing on products that require less energy." Bureau officials attributed this year's savings to nationwide conservation efforts, faster growth of industries requiring less coal than of major coal-consuming industries, and successful research on cutting energy needed in certain manufacturing processes. [Text] [Beijing XINHUA in English 1429 GMT 4 Sep 86] /9604

CSO: 4010/76

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